J. Nelson Spaeth.

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TIMBER QUANTITIES IN BRITISH COLUMBIA

AN UNCRITICAL REVIEW

BY P. Z. CAVERHILL

Chief Forester, Forest Branch, Victoria, B. C.

Considerable comment has appeared in the trade journals recently regarding the quantity of standing timber in British Columbia. In the November (1921) JOURNAL OF FORESTRY was published an article by R. W. Hibberson, of Victoria, which tends to create an unduly pessimistic impression as to the quantity and accessibility of the timber in the Province, especially as Mr. Hibberson mentions such well-known names as A. L. Clark and Dr. Judson Clark as authority backing up his contentions.

The writer believes that some good may be accomplished by a review of the situation regarding the timber in the Province, a bringing together of the various estimates made, and if possible in seeing the question from the viewpoint of the person making that statement. The reader will then be in a position to judge for himself as to conditions and the future of the lumber industry.

The Province reaches from the 49th to the 60th parallels of latitude and, extending from the Pacific Ocean over three ranges of mountains and their intervening valleys, has an average width of 400 miles. Of a total area of 225,000,000 acres it is more or less covered with timber in various stages of growth. Prince George may be considered the geographic center, yet north of the line of the Grand Trunk Pacific the country is largely unexplored and unorganized. What few reports are available indicate timbered valleys of considerable extent, as Parsnip, Nelson, Babine Lake, Findlay, and the Leard. Any estimate made of the timber, therefore, can be made only with a knowledge of a wide margin of possible error which should

be recognized at the start. In fact, in many respects we must still preface any estimate of the quantity of timber in British Columbia with "As far as our limited knowledge extends at the present time we may therefore conjecture," [1] or "The cruising and mapping of the timber land of British Columbia has not yet progressed sufficiently to indicate closely the total stand of timber in the Province." [2]

With this conception of the limitations of the situation firmly in mind let us proceed to examine the various estimates for what they are worth.

The first we have is that of Dr. B. E. Fernow in Canada's Timber Wealth.[3] He states:

"Actual knowledge regarding commercial timber is scanty and the scattered knowledge has not been systematically collected. We have to rely on very much generalized estimates.

"Of the vast territories of British Columbia estimated at 370,000 square miles, not more than 30,000,000 acres or 12 per cent is by well informed land lookers considered merchantable according to present standards. . . . At the present to be sure the lowest standard at the coast mills is as a rule 14 inches in 32 feet logs, and as a rule no trees under 26 inches d.b.h. are cut. Of such timber, now pretty nearly all located by timber licenses, not more than six million acres are supposed to exist, which may be swelled to 15 million of commercial character when standards are lowered, and both the northern extension and timber of higher altitudes are added, which at 15,000 feet average may indicate a stand of over 225 billion feet. In the mountain mills the average log sawn at the mill is 12 inches, of this description some 15 million acres may be found in southern Rocky Mountains which figured at 5,000 gives another 75 billion feet or altogether for Western Canada forests 300 billion feet."

This apparently does not include Northern Mountain areas. Dr. Fernow is too well known and the basis of his estimate too clearly stated to require further comments.

The next is that made in 1910 by the Royal Commission of Inquiry on Timber and Forestry. This Commission, after a year's study of the situation in which hearings were conducted at all important points

[1] Report of Forestry Commission.

[2] Dr. Judson Clark, "British Columbia Timber Primer," in Lumber World Review, January 25, 1917, May 10, 1920.

[3] Forestry Quarterly, Vol. VI, No. 4.

within the Province and all possible information on the subject secured, states:

"As far as our limited knowledge extends at present we may therefore conjecture that a forest area of 15 million acres within the jurisdiction of the Provincial Government is capable of yielding, under the present methods of logging, nearly 200 billion feet of merchantable timber, and that restrictions placed upon the present liberty to destroy and waste may increase this amount appreciably. The grand total of some 240 billion feet for all British Columbia, half the probable stand of Canada, may thus be increased by wise legislation."

This estimate is based on some 16 million acres; 11¼ million of alienated Provincial timber plus the railway belt containing one million acres of timber land and an allowance of 25 per cent for areas still vested in the Crown. This 25 per cent allowance is probably roughly correct for the coast region, and is checked by the Report of the Commission of Conservation, but for the interior, and especially for the northern interior, which contains from 25 to 30 per cent of the timber-bearing area of the Province, the title to which is still vested in the Crown, the estimate is obviously too low. The timber stand is given on timber licenses at the conservative figure of 7.7 million per section. Recent cruises on 250,000 acres of unstaked interior timber, application for which has been received for pulp, shows that the average stand in the interior of spruce and balsam will fully equal this estimate. Coast stands and stands selected for staking under timber license will average, undoubtedly, higher.

It only requires a casual visit to one of our operating regions to ascertain the fact that logging today is not the wasteful operation of a decade ago. Operating for one species is a thing of the past. Gone are the high stumps with two sets of spring boards; and the average top is utilized to 12 inches on the coast and 6 inches in the interior. We must conclude that any estimate based on conditions as existing at that time must be correspondingly increased.

Logging engineering is only in its infancy. The past 10 years has seen wonderful strides in the development of machinery and equipment. How much the development of the "High Lead," the overhead systems, the log flume, the gasoline tractor and log truck has enabled the logging of sites considered inaccessible in 1910 can only be conjectured. There appears no reason to doubt that in 10 or 15 years hence new developments along the same line will have thrown present

day methods as far in the background as the ox team with greased skids of the day when logging was concentrated on the level ground of Burrard Inlet. These changes are accounting for the ever increasing production per acre from our timbered areas.

In 1914 the Commission of Conservation undertook to gather up and compile all information available on the forests of British Columbia. They were able to avail themselves of a large number of actual cruises as well as exploratory reconnaissance and reports from land lookers. This information, carefully checked and compiled, is to be found in the "Forests of British Columbia," published by the Commission of Conservation, 1918. This report states:

"Without the co-operation of the timber owners and timber cruisers, the securing of the data upon which this report is based would have been impossible (see page 6, Introduction). Most valuable information was also supplied by the Provincial Forest Branch, the Dominion Forestry Branch, the Forestry Branch of the Canadian Pacific Railway and the Land Department of the Esquimalt and Nanaimo Railway.

"Though the figures submitted in Chapters 2 and 3, Part II, are, in most instances, given in comparative detail, it must be remembered that they are only estimates, based on the best information available at the time. Later and more intensive survey will doubtless reveal local inaccuracies, but, since the estimates are based on such a large proportion of actual cruises (about 65 per cent), the total estimates for the various drainage basins represent, with a reasonable degree of accuracy, the amount of merchantable timber in each.

"In this report, accessibility, so far as situation is concerned, has not been considered, since it is such an uncertain factor. The sizes which are considered merchantable vary for different parts of the Province, for different species, and for the purposes for which the timber can be used. In this estimate the term merchantable is understood to include such timber as can be used for the ordinary commercial purposes, such as the manufacture of lumber, shingles and wood-pulp, or as piling, poles, railway ties or mine timbers."

The estimate of saw material is given at 350 billion feet. This is material of sufficient size and quality to be suitable for sawing purposes without considering accessibility, as it was readily recognized that changing methods and increasing stumpage values would from year to year convert commercially infeasible sites into profitable logging chances.

This report shows an area of 7¼ million acres on the Coast containing in excess of 10,000 feet per acre, or a total of 214 billion feet b.m. and 10¾ million acres in the interior containing in excess of 5,000 feet per acre, or a total of 94 billion feet. In addition in the interior are some 15 million acres containing an estimated 42 billion feet, or from 1,000 to 5,000 feet per acre and not classed as timberland.

The total timberland on the coast checks with the report of the Royal Commission mentioned above, but in the interior, and especially considering the 10¼ million acres of timber-bearing lands in the northern interior, this later estimate, is obviously nearer correct than the report of the Royal Commission.

Excluding Northern British Columbia, which apparently received little attention from the Commission, and considering only timber over 5,000 feet per acre we have 13½ million acres containing 272 billion feet as compared with 240 billion, or again adding the 9 million acres of timber bearing land under 5,000 feet per acre, containing 25 billion feet board measure we have 22½ million acres and 297 billion feet—a very close check on Dr. Fernow's estimate.

In the Lumber World Review of July 25, 1917, the following appears:

"The fact that title could be secured to Provincial timber lands, up to December, 1907, for the formality of staking and paying the annual taxation, may be assumed to have resulted in title being taken to practically all the timber lands having sufficient value to justify the payment of the taxes (license fees). A more leisurely survey of the forest resources has shown that some valuable areas were overlooked, but it has also developed the fact that there were included many areas not sufficiently timbered to be of commercial value. The one factor largely offsets the other, and it is fair to say, broadly speaking, that in the judgment of the lumber industry the Province of British Columbia is commercially timbered to the extent of about 5 per cent of the total area.

"In addition to the 5 per cent of commercially timbered lands, as noted above, there is 10 or 15 per cent of the area of the Province that bears a forest growth that will eventually come to have commercial value as the prices of wood products increase and new ways are found to log more cheaply the lighter and less accessible stands of timber.

"The cruising and mapping of the timberlands of British Columbia has not as yet progressed sufficiently to indicate closely the total stand

of timber in the Province. Tentatively, it may be placed as being in the vicinity of 350 billion feet, but of this total not more than 200 billion feet has been adjudged to have a present commercial value by being honored by purchase by private interests. And of this 200 billion feet about 60 billion feet would interest a logger on the basis of the lumber prices prevailing during the past 5 years." [4]

Mr. Clark's 5 per cent checks with the Commission of Conservation report on 13½ million acres for coast and southern interior, whereas his 12 to 15 per cent checks with 33 million acres of land bearing timber as given by the Commission's report.

It is here admitted by Mr. Clark that the basis for absolute estimate is lacking. He accepts the tentative figure of 350 billion feet, but adjudges not more than 200 billion feet to have monetary value since it had not been taken up by purchase. In this connection the taking up of timber is no criterion of value. More timber would have been staked except for the withdrawal of the privilege on December 24, 1907. Much of the timber staked during the period prior to the above date is so situated that it cannot be logged for years to come, as instanced by the number of licenses allowed to lapse, whereas many of the areas omitted from the staking have a real commercial value as illustrated by sales of Crown stumpage. In the last 5 years $1,600,000 has been received in stumpage and royalty from timber cut on areas excluded in above estimate and many more sales are now under contract. During the last 5 years material contracted for includes: Saw material, 1,174,000,000 feet; 10 million linear feet of piles; 235,000 cords of shingle bolts, and 9,500,000 railway ties, with a total estimated value of $3,952,000.

This timber is sold under contract for immediate operation and these figures show that there is a real value in timber not included in areas previously alienated from Crown Land.

Dr. Clark, therefore, appears to approach the subject from the point of view of value as illustrated through commercial transaction in stumpage. This is obviously wrong in considering the reserves of timber in case of a future shortage.

The estimate of A. L. Clark [5] needs careful consideration and I quote from it at length to show his position:

(*a*) "That I most unqualifiedly believe this report of 350,000,000,000 feet of saw timber in British Columbia is unwarranted, and will not check out with the facts.

[4] Dr. Judson Clark, British Columbia Primer.

[5] Lumber World Review, May 10, 1920.

(*b*) "There may be 350,000,000,000 feet of timber, including all kinds and qualities accessible and inaccessible, for be it remembered that it is a large and extensive area, embracing within its limits the most extensive mountain sections and ranges of this continent outside of Alaska, and there is more or less timber everywhere you go; but to call all this scattered unrecoverable timber of all kinds and quality, and to class all this as available and merchantable saw timber, is unwarranted and misleading in my opinion. There is some good merchantable timber of good quality in some of the mountain ranges, but it is costly and difficult to get out. It is a fact perhaps not generally known that there is a forest of spruce of wide extent, extending from the northern reaches clear to the Arctic Ocean, but this spruce timber is small, scrubby and of inferior quality, and totally unfit for commercial saw purposes. Probably in distant years to come it may be utilized for pulp. It would be some intrepid man who would undertake building any kind of transportation facilities into that northern Arctic region, and we therefore need not now concern ourselves over that contingency.

(*c*) "It is my opinion that the real commercial saw timber is confined to the coast, and it is circumscribed at that. I became convinced early in my experience up there that the commercial timber stand was badly over-estimated and over-stated. The popular notion about this has been veering decidedly to that view. Through the years and during the time I have been operating there, the annual cut of that Province, from the choicest and most accessible of this timber, had made a decided and perceptible inroad upon it, so much so that it is now being felt. I give it as my unqualified conviction that the accessible, commercial, saw timber in British Columbia is not over 150,000,000,000 to 180,000,000,000 feet, and at that I believe it will be over-stated. Most of the choicest and most accessible commercial timber of the original areas that could be logged at reasonable expense will be found to have already disappeared.

(*d*) "As to this large quantity of young trees that would produce, as estimated, 5,000 or 7,000 millions of feet every year. I regard that as pretty nearly fiction. In the first place it is on the logged off land that the forest fires are continually occurring. They burn up the young timber, and I believe that one who can see so large as these statements are must be 'seeing things.'"

The points in this are:

(1) "There may be 350 billion feet of timber including all kinds and qualities accessible and inaccessible.

(2) "It is my opinion that the real commercial saw timber is confined to the coast and it is circumscribed at that.

(3) "It is a fact perhaps not generally known that there is a forest of spruce of wide extent from Northern reaches clear to the Arctic Ocean."

It is evident that Mr. Clark is considering the question from the standpoint of the Pacific Coast only and is speaking in terms of coast lumber. He does not see any commercial value in anything but the large timber for which the coast is famous and from this viewpoint we find little difference in the various estimates. The Commission of Conservation gives 214 billion feet on the entire coast, 177 billion for Vancouver Island and the lower mainland, against his 150 to 180 billion feet on a circumscribed area.

I cannot agree, however, with his view in face of the facts that a large number of mountain mills are cutting material situated east of the Cascades and finding sale for it. The annual output from these mills has averaged over a quarter of a billion feet a year, and the price received for the product is not materially different from the average for the coast. Interior forests supply, in addition, most of the ties and poles shipped from the Province. With the further development of the prairies the importance of these timber reserves will be increased, and the time is coming when the interior forests will produce an amount equal to or exceeding coast production.

Steffenson, in his "Friendly Arctic" has exploded the theory of a frigid north into which only the "intrepid" dare venture. He has shown that Point Barrow, Alaska, is as congenial as Dakota. A study of the isothermal lines shows that the climate of northern British Columbia is comparable with that of Ottawa or the Sudbury district of Ontario. This is confirmed by an observation of the northern limit of common tree species. Speaking from the standpoint of plant geography, Fort Nelson and Fort Liard would be in the same latitude as the pulp-producing regions of Ontario and Quebec.

Successful agriculture has been carried on for many years by the Hudson Bay Company's officials at such points as Fort Liard, Fort Vermillion, Red River Fort, and Fort St. Johns. The potential agricultural land is extensive. The country is also rich in mineral products and fish. Steffenson has shown the vast possibilities of regions still farther north as a source of meat supply.

It does not seem, therefore, that it is too wide a stretch for the imagination to consider the day when this region will be opened to

transportation and the timber therein become accessible. Already Fort St. Johns and the Nelson River routes are proving the spring gateway to the MacKenzie oil fields. Neither, therefore, can I accept Mr. Clark's statement that these northern forests do not concern us in considering our future timber resources, and I must consider these stands as available for future development when the need warrants.

Mr. Hibberson, in his article in the JOURNAL OF FORESTRY, "Conservation of the Timber of British Columbia," states:

"To the average man in the street, British Columbia is all timbered. He travels by train through the interior of British Columbia, or by steamer up the coast and the country everywhere looks green; therefore, it must be timber. If you told him there is every danger of a timber famine in British Columbia within 15 years, you would be ridiculed; but there is a very decided danger of a timber famine, and before many years lapse, we will all begin to feel it.

"Ten years ago the center of the logging industry was within a radius of 50 miles from Vancouver. Today it is from 150 to 200 miles from Vancouver, and in some cases operators are towing logs as far as 600 miles to their mills, and an average tow of 200 miles is quite common.

"Ten years ago, the average cost of logging was \$5 per thousand feet; today it is nearly \$20 per thousand feet, and in some of our cedar camps last year, the cost was over this figure. . . ."

"Formerly a logger with a capital of \$5,000 to \$6,000 could open up a camp and produce logs; today his machinery will cost him approximately \$100,000 before he can commence to operate. I have in mind one operation, not 20 miles from here, where a logger spent \$125,000 building his logging railroad and putting in camps, etc., before he made a cent, then when he was ready to operate a slump came and he had no market for his logs. . . ."

"We have been credited in British Columbia with having 350 billion feet of standing timber. Of this I have no hesitation in saying that there will not be 100 billion feet actually taken to our saw mills in the form of saw logs. This figure, of course, refers to our virgin timber. Our present output is approximately two billions of feet per year; this figure will be more than doubled within 5 years, and by 1930 British Columbia will be called upon to supply at least 6 billion feet per year, possibly more. . . .

"A. L. Clark, President of the Vancouver Lumber Company, some time ago had courage enough to state that we had not nearly the

amount of timber in British Columbia that we are credited with. He estimated our resources at approximately 150 billion feet. Dr. Judson Clark, a well-known authority on timber in British Columbia, estimates the total stand of accessible merchantable timber to be approximately 100 billion feet. Personally, from 17 years' observation and examination of the timber in British Columbia by our firm, I incline to the figures as given by Dr. Clark.

"British Columbia has an area of 359,000 square miles, of which only 40,000 miles is commercially forested; 110,000 square miles of our timber lands containing 665 billions of feet has been totally destroyed and as the humus has been burned it will be centuries before it is again covered with a forest growth. The Slocan and southern boundary countries of British Columbia have been so burned that many of the mines and mining towns have to ship their mining timber and fuel by rail, distance up to 70 miles. and this country a few years ago was heavily forested.

"Of the 40,000 square miles of commercial forest in British Columbia only 50 per cent can be seriously considered as containing accessible loggable timber; the balance being on rocky, steep ground, where the cost of logging and the breakage would be so great that it would not tempt a logger to operate for many years to come.

"The virgin growth of timber in British Columbia is steadily decaying and should be cut and marketed, but the young, second growth on which we depend for our future supply of lumber should be jealously preserved. At present we are recklessly cutting it for tie timber, poles and mining timber, destroying fully 30 per cent of it during the operation. It is common practice to leave 20 to 40 feet of good, sound butt logs in the woods, because it is too large to hew into ties. The same condition applies to operations where mining timber is being logged. This should be checked, and without waste of time. Depletion of our forests in British Columbia within 20 years, with a resultant slump in all enterprise that depends wholly or in part on forest products, can only be averted if action is taken without further delay."

While not wishing to decry the need for adopting conservation methods it is impossible to let these statements go without comment. Thus the increasing cost of logging is apparently attributed to the disappearance of accessible timber, although we all know that this increase was largely due to inflation and prices had started to deflate long before the article was published.

It is quite true that in the early days logging was confined to Burrard Inlet and Howe Sound. The cut, at that time, however, was limited. As the industry grew the scene of activity expanded. By 1908 records show that active logging was going on in Sayard, Valdez, Bute Inlet, Broughton Island, Comox, etc., and by 1912, had spread to the present extent. The output for the whole province as shown in royalty returns in 1905 was 402 million feet. The years 1907-9 show an average scaled for coast of 400 million. The quantity cut within the radius of 50 miles of Vancouver could not have exceeded 150 million at that time and we have today within that region a producing capacity of 125 to 150 million feet, with timber reserves sufficient to carry this production for 15 to 20 years at least, so there seems little change in activity within 50 miles of Vancouver.

The increase in capital cost of logging follows naturally upon the transition from animal to machine logging, and is no more a criterion of a lumber shortage than the industrial revolution in England in which the craft system was superseded by the factory was an indication of loss of prestige in manufacturing.

Mr. Hibberson accepts the estimate of the Commission of Conservation for the timber destroyed by fire which he places at 6 million feet per square mile, but he refuses to accept the same estimate on what he states contains accessible loggage timber—this he places at 20.000 square miles and less than 100 billion feet.

It is an axiom that no estimate could be made on areas destroved by fire except by comparison with similar stands of growing timber and if the Commissioner's estimate should be reduced on the standing green timber it should be similarly reduced on the burn: moreover, of the burned area, 95,000 square miles (87 per cent) is east of the Cascades in the higher stands, where A. L. Clark is doubtful if there is any really commercial saw timber, and only 13 per cent is on the coast in the heavier stands. On the other hand, over 10,000 square miles, or more than 50 per cent of Mr. Hibberson's estimate of the area of merchantable timber, is west of the Cascades in the heavy coast stands, and has been alienated for timber purposes, or according to Dr. Clark, has been adjudged to have a commercial value by being honored by purchase by private interests. So that surely there is no cause for a reduction on these areas over that allotted to the burn.

He again gives the total cut as two billion in comparison with his 100 billion of accessible merchantable timber (Clark's 150 to 180 billion).

The logs scaled for all purposes have averaged 1.5 billion feet b. m. during the past 5 years. Only in 1920 did the quantity exceed this amount when it rose to 1.8 billion feet b. m. from which should be deducted between 200 to 300 million going to the pulp plants to arrive at the actual sawmill requirements.

The balance of the scale is made up of shingle bolts, ties, poles, and mine props, a largely salvage material, and including this only reached the 2 billion mark for the one year, 1920. It is obvious that these figures of Mr. Hibberson's are too erratic to be checked and therefore cannot be accepted.

Mr. Hibberson is opposed to the policy of making ties. A study of the hewn tie business discloses the fact that these are almost exclusively made in the interior; during the past several years only 10 per cent of the production having come from the coast. Moreover, in the interior, ties are made chiefly from lodgepole pine (*Pinus contorta*), a species which matures at tie size and is not sought for milling purposes at the present time. Tie operations in such stands appear to be good forestry practice and desirable business.

Since it has been mentioned in connection with the above estimates, growth needs a passing glance. Any estimate of growth is tentative, since very little growth data are available.

A. L. Clark states he considers the estimate of 5,000 to 7,000 million as pretty nearly fiction. Dr. Judson Clark states:

"As regards the theory that there are 5,000 to 7,000 million feet produced each year by annual growth, we are in perfect accord with your view. In an article published 11 years ago, I expressed the view that the total annual growth of the forests of the province would be in the vicinity of 4,000 million feet, but, of course, took occasion to point out that in the case of all 'virgin forests,' such as obtain throughout British Columbia, and the annual growth is normally offset by the annual loss through windfall and decay. These forests have been here for thousands of years, and it is a fair guess that the actual amount of sound timber is not greatly different today from what it was hundreds of years ago. The only change that has come into the situation has been the logging of considerable areas. This, however, has not yet made any substantial difference in the profit and loss balance, for the frequency of fire on the cutover lands, has in a very large measure prevented the reproduction of the forest with any commercial promise."

Mr. Hibberson states:

"It takes approximately 80 years to produce trees of commercial size that will make ties and piling for the coast or sawlogs for interior mills. Eventually our coast mills will have to adapt their cutting machinery for small logs, for the virgin timber once gone can never be replaced. It takes from 200 to 400 years to produce our large fir timber, and double that to produce our big cedar. The fortunate owner of a tract of virgin cedar and fir will, if only he can afford to hold it for a few years, reap a rich reward."

If on account of the differing viewpoints, as expressed above, there is a misconception of the quantity of standing timber, this difficulty is magnified in attempting to estimate growth in figures of board feet. For in addition to quality and accessibility we have to consider that a young stand goes on year after year for 50 to 60 years building up wood supply which cannot be estimated in board feet because the trees have not yet reached size sufficient to produce sawn lumber. Then suddenly the stand changes from pole size to log size and contains 10,000, 20,000 or 50,000 thousand board feet per acre.

The estimate of growth given for British Columbia is based on this empirical figure of 100 board feet per acre applied to the 100,000 square miles of immature timber. Very little work has been done on growth studies. We know that in many localities this figure is low, but on much of the area the stocking is below normal.

Substantiating the estimate, however, are: Actual cruises made show interior stands 80 to 125 years old, containing 8,000 to 10,000 feet per acre. Growth studies undertaken on hemlock cedar stands on the north coast show an average annual yield of 150 to 400 board feet per acre per year. In Douglas fir stands cruising as high as 70,000 feet have been produced in 60 years. It must be remembered, however, that this timber is not the size of the mature coast timber, although some of these stands are now being cut on the coast.

One timber company has just logged a stand from which a ring count on stumps showed stump diameters to be: Cedar, 19¼ inches in 60 years; fir, 25 inches in 62 years; hemlock, 24 inches in 60 years.

Sweden and Finland are very similar to our interior. Situated between the 56th and 70th parallels, they are 10 degrees farther north. The climate is moderated by the influence of the Gulf Stream, which sweeps the coast of Norway. The air currents affect Sweden and

Finland only after crossing the Kiolen Mountains, a range 7,000 feet in height, their effect thus being similar to that of the Japanese current on the climate of British Columbia. Sweden and Finland lie between the mean annual isotherms 30 to 48, British Columbia, between 35 and 50. Winter temperatures reach –59° and in Sweden lakes remain frozen from 4 to 6½ months. Species of timber are also similar, being mostly spruce. Some comparison may, therefore, be drawn on growth.

In Sweden the annual increment is given as 1,312,000,000 cubic feet on 55,000,000 acres of forest land, or 24 cubic feet per acre. Allowing 8 board feet per cubic foot, this means 200 board feet per acre per year.

Finland produces 1,242,000,000 cubic feet on 50,000,000 acres, or 26 cubic feet per acre, again equivalent to approximately 200 board feet; 120 cubic feet of logs yield 1,000 feet of lumber. It would, therefore seem that 100 board feet per acre could be accepted as within reason for our interior areas until some more definite figure can be obtained, especially when applied only to the young stands after eliminating barrens and mature timber on which no growth occurs or is offset by decay.

The conclusions I have come to after careful study of the question are:

(1) There is still a large stand of timber in the Province. That irrespective of species and loggability under present methods and prices, this will reach, in all probability, 350 billion feet or more.

(2) That logging methods are changing and logging machinery developing so that more and more material considered inaccessible at any one time becomes accessible at future dates and in the next 50 or 100 years logging engineering will probably develop so that inaccessibility will be a term connected with logging history only.

(3) The present cut of all species and kinds, including poles, ties, and shingle bolts, for commerce is approximately 2 billion feet, to which must be added wood cut for local use in rural districts and timber for farm purposes, which will add another quarter of a billion feet; this will increase, with the demand of increasing population, the depletion of southern pine and the awakening of the Orient to western ideas of civilization and need of wood products to sustain that civilization. In 10 or 20 years we may be called upon to supply 5 or even 6 billion feet per year.

(4) With the increased demand stumpage will increase or permit of greater expenditure for recovery, so that much of the increased pro-

duction will be saved from material now going to waste, it being an economic law that a raw product will be wasted when the cost for recovery is a sum in excess of the market value. Future increases will also tend to be along lines of development for pulp and special uses which can utilize the smaller timber.

(5) Timber of the character of mature coast Douglas fir cedar and Sitka spruce cannot be replaced. This timber has required 300 to 1,000 years to produce and should be regarded as a specialized wood used only for special purposes, whereas ordinary needs will be supplied from second growth.

(6) Nature has treated us generously in regard to timber and with a little care new forests spring up to replace the old. Most of the growth today is on the burned-over lands of the interior plateaus and will be of mountain quality only. The quantity of this growth depends upon the success with which we control fires. Given a fair degree of fire protection and reasonable utilization, we should maintain, when logging is developed throughout the whole Province, a forest industry at least equivalent to Sweden, which, after supplying the needs of 5,000,000 people, exports 2 billion feet.

FRUSTUM FORM FACTOR VOLUME TABLES FOR WHITE, NORWAY, AND JACK PINES IN MINNESOTA [1]

By T. Schantz-Hansen

Cloquet Forest Experiment Station, Division of Forestry, University of Minnesota

FOREWORD

In presenting the following tables, a word of explanation is necessary. They are not presented as a finished product, but more in the nature of a progress report. While the coming seasons will see more work of this nature, it is hoped that by presenting the tables now they will be used and checked by others. In spite of the fact that they have not been fully checked in the field, it is felt that they are dependable. Past work has shown the reliability of the method used.

OBJECT

The purpose of this study was not to prove any new theory in regard to frustum form factors, but rather to produce some dependable volume tables of more than local application for the three species of pine found in Minnesota. The existent volume tables are based largely on diameter alone, which makes them purely local in character. At the same time the comparative value of using taper tables or actual field measurements was determined. Tables for jack pine and Norway pine were constructed on the basis of these measurements. Volume tables based on height and diameter for these species were checked at the same time.

METHOD

The theory of frustum form factors is so well known that it needs no explanation. There are, however, several different methods of completing the table which give varying degrees of accuracy. Check figures were available for white pine, so several different methods of construction were tried and checked. The following method was found to

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produce the most accurate table. A base table of frustum volumes, computed by the Scribner Decimal scale to the nearest tenth inch, was first constructed (see Tables 6 and 7). The volumes of trees were computed by the Scribner Decimal C scale. The volume of an equal number of frustums of cones with the same dimensions as the trees were then computed. The total volume of the trees of a given diameter class was then divided by the total volume of the frustums of that class, giving a form factor for each diameter. The form factors were then plotted on d.b.h.; small irregularities evened off and the factors not in the original data secured. The volumes of the frustums of each diameter class were then multiplied by the factor for each diameter class. This gave the final table.

It has been contended that the most accurate table would be constructed by using a separate form factor for each diameter and log height class. To see whether or not the factors followed any definite law, these separate factors were worked out for white pine. In general the factors decreased with increase in height within a given diameter class and increased with increase in diameter within a given height class. This relationship was not constant, however, and seemed to indicate that the number of trees used was not sufficient to apply this method.

WHITE PINE

The figures used in constructing this table were taken as a part of a mill scale study of white pine made in St. Louis County during the winter of 1912-13. The measurements taken in the woods consisted of diameter breast high, diameter inside bark on stump, stump height, diameter inside the bark at the small end of each log, and the log lengths.

The top diameter inside bark was found to be quite variable, ranging from 5 to 10 inches with no constant relationship to the d.b.h. The average cutting limit was found to be 7.2 inches and the table was accordingly constructed to conform to a 7-inch top d.i.b. In using a single top cutting limit for so wide a variety of limits, there would be a chance for a great deal of error if the same irregularity did not exist in cutting practice as was found in the trees used as a basis. The closeness of the check seems to show that this assumption was warranted. The check trees showed a variety in top cutting limit of

from 4 inches to 10 inches with an average of 6.8 inches. It is believed that this indicates the average top utilization of white pine cutting in this state and any errors arising from the use of a single limit would be compensating.

The plotted frustum form factors give an indication of the form of growth of the white pine. The rapid rise in the curve for the smaller diameters indicates that the taper decreases rapidly with age. At the age represented by the 20, 21, and 22 inch diameter classes, there is the least taper and consequently the greatest relative volume (by relative volume is meant the volume of the tree in relation to the volume of its corresponding frustum). This period probably represents the culmination of the best growth. After this point there is a gradual drop in the curve indicating an increase in taper and a smaller relative volume. This increase in taper might be caused by any one of three things or by all of them; the persistence of the crown, the increase in thickness of the bark at and the extension of the root swelling to the d.b.h. point, when that size has been reached. Further work is necessary definitely to establish this conclusion.

Table 1 gives the most accurate results when checked. The table was computed to the nearest five board feet. This is inconsistent with the use of the Scribner Decimal C rule, but it was felt that no accuracy would be sacrificed in so doing and the value might be increased. The table was also figured to half log lengths that it might be used where more accurate work was desired.

To learn the true value of any volume table, its accuracy must be checked. In the May, 1920, JOURNAL OF FORESTRY, an article by Mr. Bruce gives a standardized check for volume tables. All of the following tables were checked by this method. The total volume of the trees by table was checked against the total volume by scale and the average deviation of the volume of the individual tree in the table from its true volume was found.

The scale of basic trees being 151,280 board feet and the volume by table being 150,921, or a difference of 259 board feet gave an error of .1 per cent entirely within the limits set by Mr. Bruce. The average deviation was found to be 13.7 per cent, slightly higher than the standard proposed by Mr. Bruce, but not too high in view of the small percentage of error in the total.

TABLE 1.—*Volume Table. White Pine,* P. strobus. *St. Louis County, Minn.*

Scribner Decimal C Frustum Form Factor Method.

No allowance for cull. Stump 12 to 18 inches. Top d.i.b. 7 inches. Basis 444 trees. [Height 16-foot logs.]

D.B.H.	2	2½	3	3½	4	4½	5	5½	6	6½	7	Curved F.F.F.
8	40	45	60	......	......	......	......	......	......	......	......	.66
9	40	50	60	75	90	......	......	......	......	......	......	.71
10	50	60	75	90	105	115	......	......	......	......	......	.76
11	55	70	95	110	130	145	......	......	......	......	......	.81
12	70	85	115	130	155	175	......	......	......	......	......	.86
13	80	100	125	150	180	200	230	......	......	......	......	.90
14	90	110	145	170	210	235	270	305	......	......	......	.95
15	......	120	165	200	235	260	305	340	......	......	......	.99
16	......	135	195	220	260	295	345	395	......	......	......	1.02
17	......	155	210	245	300	350	400	440	485	......	......	1.05
18	......	170	230	275	345	390	440	485	570	......	......	1.08
19	......	190	265	315	385	425	490	545	615	......	......	1.10
20	......	215	285	350	410	460	545	585	675	730	......	1.11
21	......	235	300	365	440	510	600	660	735	800	......	1.11
22	......	......	320	400	485	555	655	715	805	890	......	1.11
23	......	......	350	425	530	600	705	775	880	950	......	1.10
24	......	......	375	460	565	650	750	830	940	1,020	1,120	1.10
25	......	......	405	505	600	680	775	890	1,000	1,090	1,215	1.09
26	......	......	......	535	625	725	780	960	1,080	1,170	1,295	1.08
27	......	......	......	560	665	780	920	1,020	1,130	1,230	1,370	1.07
28	......	......	......	595	715	835	965	1,080	1,195	1,325	1,460	1.06
29	......	......	......	......	755	870	1,030	1,145	1,285	1,400	1,565	1.05
30	......	......	......	......	790	955	1,100	1,205	1,370	1,510	1,645	1.04
31	......	......	......	......	855	1,025	1,135	1,280	1,452	1,575	1,710	1.03
32	......	......	......	......	890	1,040	1,195	1,345	1,500	1,640	1,785	1.02
33	......	......	......	......	940	1,100	1,250	1,395	1,570	1,715	1,890	1.01
34	......	......	......	......	990	1,155	1,315	1,465	1,660	1,805	2,010	1.01
35	......	......	......	......	1,020	1,200	1,360	1,600	1,745	1,910	2,120	1.00
36	......	......	......	......	1,055	1,265	1,460	1,655	1,825	2,000	2,200	1.00
37	......	......	......	......	1,110	1,305	1,525	1,715	1,890	2,055	2,270	.99
38	......	......	......	......	1,160	1,370	1,585	1,795	1,985	2,145	2,300	.99
39	......	......	......	......	1,220	1,415	1,640	1,875	2,015	2,195	2,465	.98
40	......	......	......	......	1,260	1,485	1,715	1,900	2,115	2,375	2,595	.98

Field work by Skibo Mill scale study crew. Computation by T. S. Hansen.

The preceding check gives an indication as to the accuracy of the table, but does not indicate its applicability. In the early fall of 1919 figures were secured for checking the applicability of the table. The 100 trees measured for checking were located in St. Louis County on the Virginia Rainy Lake Company's cuttings east of Cussen at Camp 61. The stand was typical of that region where Norway pine covers the rocky ridges and white pine fills the draws. As a matter of contrast the table was checked against two diameter tables; one constructed by Chapman in 1903 for white pine in St. Louis County, the other constructed by Bruce in 1902-3-4 for white pine in Cass County. The following table gives the result obtained by the comparison.

Check of Volume Tables on Basis of 100 Scaled Trees.

Table	Volume by table	Volume by scale	Per cent error	Basis trees for table
Bruce	39,066	49,555	—21.1	2,496
Chapman	47,440	49,555	— 4.4	1,617
Form Factor...	50,797	49,555	+ 2.4	440

In addition the average deviation for the form factor table was computed and found to be 7.6 per cent. The two diameter volume tables are of course purely local and consequently the comparison is hardly just. It does serve, however, to illustrate the differences possible in local tables. The check trees were taken in St. Louis County, the district for which Chapman's table was constructed. Consequently it would check much closer than Bruce's table, which was constructed for a different district.

The two preceding checks show both the accuracy and applicability of the table as constructed by the frustum form factor method. Further checking is necessary to determine how wide a range its applicability covers.

NORWAY PINE

Figures for the Norway pine table were secured in the fall of 1919 on the Virginia Rainy Lake Company's cuttings in St. Louis County. The time was only long enough to secure measurements on 100 trees. The trees were well distributed throughout the various diameter classes, so it is felt that a reasonably satisfactory basis for the table was secured.

The top cutting limit for Norway pine was found to be very uniform and averaged 5.9 inches. The same method of construction was followed as in the building of the white pine table.

Using this cutting limit, 6 inches, another table was constructed from the figures in the taper tables for Norway pine in the United States Department of Agriculture Bulletin 139, "Norway Pine in the Lake States," by T. S. Woolsey, Jr., and H. H. Chapman. The same method of construction was used for both of these tables.

Norway pine loses its taper rapidly and even at the smaller diameters and younger ages holds its diameter well up into the tree. The curve from the taper tables shows an ever increasing volume with increase, in diameter, while the curve based on the 100 trees measured in the field shows that there is a point where the relative volume is at its maximum followed by a gradual decrease. It will require additional work to show which curve gives the true form. In both cases, except for the very small trees, the volume of Norway pine never drops below that of the corresponding frustum. The small crown of mature Norways would tend to lessen the taper and keep the relative volume high. There would, however, be a tendency to reduce the relative volume because of the increased d.b.h. from increased bark thickness or extended root swelling.

Tables 2 and 3 give the results from tree measurements and taper tables respectively. It has been impossible so far to secure a satisfactory check on the applicability of the tables. Their accuracy has, however, been checked and the applicability of Table 3 checked on the basic data of Table 2. The diameter-log height table in Bulletin 139 was likewise checked as to its applicability.

The following table gives the accuracy and applicability test for Tables 2 and 3:

Table Checking the Accuracy and Applicability of Norway Pine Table.

Table	Trees basis for Table 2				Trees basis for Table 3			
	Act. scale foot b.m.	Vol. by table foot b.m.	Per cent error	Aver deviation per cent	Act. scale foot b.m.	Vol. by table foot b.m.	Per cent error	Aver deviation per cent
Table 2.......	33,050	33,384	0.8	7.9	....	....	....	4.4
Table 3.......	33,050	32,520	3.0	8.2	99,695	99,412	0.3	....
Table, Bul. 139	33,050	33,622	1.8	8.9	....	....	....	....

This check gives the accuracy check for Table 2 and the applicability check for Table 3 and the table in Bulletin 139. All the tables are reliable, but Table No. 2 seems to give the closest check. Further work to test the range the table will cover is needed to determine their value.

TABLE 2.—*Volume Table. Norway Pine,* P. resinosa, *St. Louis County, Minn.*
Scribner Decimal C Frustum Form Factor Method.
No allowance for cull. Stump height 12 to 15 inches. Top d.i.b. 6 inches. Basis, 100 trees. [Height 16-foot logs.]

D.B.H.	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	Curved F.F.F.
7	20	25	40	......	......	......	......	......	......	......	......	......	......	.95
8	20	30	50	......	......	......	......	......	......	......	......	......	......	.96
9	20	35	50	60	80	......	......	......	......	......	......	......	......	.98
10	20	35	50	65	85	100	......	......	......	......	......	......	......	.99
11	20	35	55	75	100	115	140	......	......	......	......	......	......	1.01
12	......	35	60	90	115	135	160	......	......	......	......	......	......	1.03
13	......	40	75	105	130	155	185	210	240	......	......	......	......	1.06
14	......	......	90	115	145	175	210	240	275	310	......	......	......	1.10
15	......	......	95	125	160	215	240	275	315	355	385	......	......	1.13
16	......	......	......	135	190	235	270	310	350	400	445	......	......	1.17
17	......	......	......	155	210	255	305	350	410	460	510	......	......	1.20
18	......	......	......	175	235	295	345	425	460	510	565	630	......	1.23
19	......	......	......	190	270	320	390	450	505	575	645	705	......	1.25
20	......	......	......	205	295	345	430	490	555	645	715	780	......	1.26
21	......	......	......	230	310	370	460	530	625	705	770	840	965	1.25
22	......	......	......	......	330	390	490	580	665	750	825	920	1,010	1.23
23	......	......	......	......	345	430	530	610	715	785	890	990	1,070	1.21
24	......	......	......	......	370	455	580	650	765	840	940	1,050	1,125	1.19
25	......	......	......	......	395	495	615	690	795	880	1,000	1,110	1,200	1.17
26	......	......	......	......	415	520	625	720	835	950	1,070	1,180	1,275	1.14
27	......	......	......	......	450	550	665	775	910	1,020	1,140	1,260	1,350	1.13
28	......	......	......	......	......	595	705	830	960	1,070	1,205	1,320	1,455	1.12
29	......	......	......	......	......	620	755	865	1,025	1,150	1,290	1,410	1,540	1.11
30	......	......	......	......	......	......	790	945	1,105	1,220	1,375	1,520	1,680	1.11
31	......	......	......	......	......	......	850	1,005	1,155	1,300	1,460	1,630	1,750	1.10
32	......	......	......	......	......	......	905	1,060	1,240	1,385	1,540	1,690	1,855	1.10
33	......	......	......	......	......	......	970	1,130	1,290	1,465	1,630	1,775	1,945	1.09
34	......	......	......	......	......	......	1,025	1,170	1,340	1,490	1,710	1,860	2,040	1.08
35	......	......	......	......	......	......	1,055	1,210	1,390	1,580	1,790	1,960	2,175	1.07
36	......	......	......	......	......	......	1,080	1,280	1,450	1 670	1,870	2,025	2,280	1.06

Field work and computation by T. S. Hansen.

TABLE 3.—*Norway Pine*, P. resinosa, *Minnesota*.

Scribner Decimal 3 Frustum Form Factor Method

No allowance for cull. Stump height 2 feet. Top d.i.b. 6 inches. Basis, 162 trees from taper table, Bul. 139. [Height 16-foot logs.]

D.B.H.	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	Curved F.F.F.
8	20	25	40	......	......	......	......	......	......	......	......	......	......	.95
9	20	30	50	60	80	......	......	......	......	......	......	......	......	.97
10	20	35	50	65	85	100	......	......	......	......	......	......	......	.99
11	20	35	55	75	100	115	140	......	......	......	......	......	......	1.02
12	......	35	60	90	110	140	160	......	......	......	......	......	......	1.04
13	......	40	75	100	130	155	185	210	240	......	......	......	......	1.06
14	......	......	85	110	140	175	210	240	270	300	......	......	......	1.08
15	......	......	95	120	155	205	230	270	300	340	370	......	......	1.09
16	......	......	......	130	180	220	255	295	330	380	425	......	......	1.11
17	......	......	......	145	200	240	285	330	385	435	480	......	......	1.13
18	......	......	......	160	220	280	320	395	435	475	530	590	......	1.15
19	......	......	......	175	250	300	360	420	470	535	600	655	......	1.16
20	......	......	......	195	275	320	400	455	515	600	665	725	......	1.17
21	......	......	......	220	300	355	440	505	595	670	730	800	920	1.19
22	......	......	......	......	320	380	480	565	650	730	805	900	990	1.20
23	......	......	......	......	345	430	530	615	715	785	890	990	1,070	1.21
24	......	......	......	......	380	465	590	675	785	860	965	1,070	1,150	1.22
25	......	......	......	......	420	520	645	725	835	930	1,050	1,170	1,270	1.23
26	......	......	......	......	455	565	680	780	905	1,030	1,160	1,280	1,390	1.24
27	......	......	......	......	500	605	735	855	1,005	1,130	1,260	1,400	1,490	1.25
28	......	......	......	......	......	670	795	935	1,070	1,200	1,350	1,490	1,640	1.26
29	......	......	......	......	......	710	860	990	1,175	1,315	1,475	1,600	1,780	1.27
30	......	......	......	......	......	......	910	1,090	1,275	1,410	1,575	1,750	1,940	1.28
31	......	......	......	......	......	......	995	1,180	1,350	1,520	1,710	1,910	2,060	1.29
32	......	......	......	......	......	......	1,070	1,250	1,450	1,585	1,810	1,980	2,180	1.29
33	......	......	......	......	......	......	1,155	1,345	1,540	1,730	1,925	2,110	2,310	1.30
34	......	......	......	......	......	......	1,245	1,420	1,630	1,810	2,080	2,260	2,490	1.31
35	......	......	......	......	......	......	1,290	1,485	1,700	1,915	2,200	2,400	2,520	1.32
36	......	......	......	......	......	......	1,350	1,590	1,810	2,080	2,320	2,550	2,800	1.32

Computation by T. S. Hansen.

JACK PINE

Measurements for the jack pine table were made in the Minnesota National Forest where a sale of jack pine was in progress during December, 1919. The cutting was being done in a stand partially killed by fire, but the trees were in no way injured for volume measurements. The stand was two-aged, consisting of patches of 40 to 50 year old timber alternating with 90 to 100 year old trees. The area was typical of that region and gave a wide variety of sizes to be used as a basis for the table. A total of 305 trees was measured.

The table is figured to a 6 inch top cutting limit. They were actually cutting as low as 2½ to 3 inches, but it had not yet been definitely decided that they would continue this practice. So the actual top d.i.b. was disregarded and the smallest top which could be scaled practically was assumed.

A similar table with the same top cutting limit was constructed from taper tables in U. S. Department of Agriculture Bulletin 820, "Jack Pine," by Wm. D. Sterret.

The same method of construction was followed in these tables as in the previous ones.

When based on taper tables the form factors show a gradual rise with increasing diameter. This is in distinct contrast with the trend of the curve based on results from measurements. The form factors based on actual measurements show very little taper even in the smaller sizes. There is a sharp rise and an early culmination of the relative volume followed by a rapid drop. This seems to indicate an increased taper in large trees, probably due to the persistence of the crown and thickness of bark at breast height combined with the upward extension of the root swelling. Which is the true form cannot be definitely stated without further work.

Tables 4 and 5 give the results for tree measurement and taper measurements respectively.

During the summer of 1920 work on a cord volume table for jack pine made available figures for the checking of the tables. The following table gives the results.

This check shows the table based on tree measurements to be sufficiently accurate and slightly more applicable than the other tables, the table from Bulletin 820 giving the poorest check. This may be due to

Check of Jack Pine Volume Tables.

Table	Location trees	Volume by scale	Volume by table	Per cent deviation	Average deviation, individual trees, expressed in per cent	Trees in check
Tree Measurements	Basic data					
	Table 4........	8,167	8,008	—1.0	7.5	100
	Cass Lake.....	10,015	10,352	+3.2	7.8	107
	Itasca Park....	1,775	1,830	+3.0	4.3	96
Taper Tables	Volume tapers.	6,244	6,194	—0.7	5.6	Taper table
	Basic data					
	Table 4........	8,107	7,539	—7.0	8.3	100
	Cass Lake......	5,460	5,346	—2.0	8.2	107
	Itasca Park....	1,775	1,756	—1.0	4.6	96
Bulletin 820	Basic data					
	Table 4........	7,916	6,871	—13.0	14.0	88
	Cass Lake.....	5,177	4,785	— 7.7	15.1	90
	Itasca Park....	1,505	1,165	—22.7	17.4	61

the fact that there is a marked difference in utilization now than when this table was constructed.

The measurements taken on the following check trees made it possible to work out the scale, using only 8-foot logs and using 16-foot logs as much as possible. The results are rather interesting. The following table gives the result using only the total volume and checking it against Table 4.

When scaled as 16-foot logs, we find this size of timber giving from 11.3 per cent to 16.2 per cent more volume than if scaled as 8-foot logs. In buying timber of this size, it would be to the buyer's advantage to specify that the timber be purchased on the basis of 8-foot logs.

GENERAL

The tendency of the curves of the form factors when plotted on d.b.h. gives an indication as to the growth and development of the tree. In

Location of check trees	Volume scaled as 16-foot logs	Volume by Table 4	Error, per cent	Volume scaled as 8-foot logs	Volume by Table 4	Error, per cent
Cass Lake...	10,015	10,352	+3.2	8,895	10,352	+16.2
Itasca Park.	1,775	1,830	+3.0	1,485	1,830	+18.9

TABLE 4.—*Volume Table. Jack Pine,* P. divaricata. *Cass County, Minn.*

Scribner Decimal C Frustum Form Factor Method.

Top d.i.b. 6 inches. Stump height 9 to 12 inches. No allowance for cull. Basis, 305 trees. [Height 16-foot logs.]

D.B.H.	½	1	1½	2	2½	3	3½	4	4½	5	5½	6	Curved F.F.F.
6	......	......	......	......	......	......	......	......	......	......	......	......	1.00
7	5	20	30	40	......	......	......	......	......	......	......	......	1.01
8	5	20	30	50	......	......	......	......	......	......	......	......	1.01
9	......	20	35	50	60	80	......	......	......	......	......	......	1.01
10	......	20	35	50	65	85	100	......	......	......	......	......	1.01
11	......	20	35	55	75	100	115	140	......	......	......	......	1.01
12	......	......	35	60	90	110	135	160	......	......	......	......	1.02
13	......	......	40	75	100	125	150	180	205	235	......	......	1.04
14	......	......	......	85	110	140	175	205	235	270	300	......	1.08
15	......	......	......	95	125	160	210	240	275	310	355	380	1.13
16	......	......	......	......	130	185	230	265	305	345	395	440	1.15
17	......	......	......	......	150	200	240	290	330	390	440	485	1.14
18	......	......	......	......	155	210	270	310	380	420	460	510	1.11
19	......	......	......	......	160	230	275	330	385	430	485	545	1.06
20	......	......	......	......	170	240	285	350	400	455	525	585	1.03
21	......	......	......	......	185	250	300	375	430	505	570	620	1.01
22	......	......	......	......	......	270	320	400	470	540	610	670	1.00
23	......	......	......	......	......	285	355	440	505	590	650	735	1.00
24	......	......	......	......	......	310	380	485	555	640	705	790	1.00
25	......	......	......	......	......	335	420	520	585	670	745	845	.99
26	......	......	......	......	......	360	450	545	625	720	825	930	.99
27	......	......	......	......	......	395	480	580	680	795	895	1,000	.99
28	......	......	......	......	......	......	525	625	730	845	945	1,065	.99
29	......	......	......	......	......	......	555	670	770	915	1,025	1,150	.99
30	......	......	......	......	......	......	......	700	840	985	1,080	1 215	.99
31	......	......	......	......	......	......	......	760	905	1,035	1,165	1,310	.99
32	......	......	......	......	......	......	......	815	950	1,115	1,240	1,385	.99
33	......	......	......	......	......	......	......	880	1,020	1,170	1,315	1,460	.99
34	......	......	......	......	......	......	......	940	1,070	1,230	1,360	1,565	.99
35	......	......	......	......	......	......	......	970	1,120	1,285	1,455	1,650	.99
36	......	......	......	......	......	......	......	1,010	1,190	1,350	1,555	1,740	.99

Field work by J. H. Allison and T. S. Hansen. Computation by T. S. Hansen.

TABLE 5.—*Volume Table. Jack Pine,* P. divaricata. *Cass County, Minn.*

Scribner Decimal C Frustum Form Factor Method.

Top d.i.b. 6 inches. Stump height 12 inches. No allowance for cull.

Basis, taper tables in U. S. D. A. Bul. 820. [Height 16-foot logs.]

D. B. H.	½	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	Curved F.F.F.
7	5	20	25	35	......	......	......	......	......	......	......	......	......	......	.90
8	5	20	30	45	......	......	......	......	......	......	......	......	......	......	.92
9	......	20	35	45	55	75	......	......	......	......	......	......	......	......	.93
10	......	20	35	50	60	80	95	......	......	......	......	......	......	......	.95
11	......	20	35	55	75	95	115	135	......	......	......	......	......	......	.97
12	......	......	35	60	85	110	130	150	......	......	......	......	......	......	.98
13	......	......	40	70	95	120	145	170	195	225	......	......	......	......	.99
14	......	......	......	80	105	130	160	190	220	250	280	......	......	......	1.00
15	......	......	......	85	110	140	190	215	250	280	315	340	......	......	1.01
16	......	......	......	......	115	165	205	235	270	305	350	390	......	......	1.02
17	......	......	......	......	135	180	220	260	300	350	400	440	......	......	1.03
18	......	......	......	......	145	200	250	290	360	390	430	480	530	......	1.04
19	......	......	......	......	160	225	270	330	380	425	490	540	590	......	1.05
20	......	......	......	......	175	250	290	360	410	470	540	600	655	......	1.06
21	......	......	......	......	200	270	320	400	455	535	600	660	720	825	1.07
22	......	......	......	......	......	290	345	430	510	580	660	725	810	890	1.08
23	......	......	......	......	......	310	390	480	555	645	710	800	890	965	1.09
24	......	......	......	......	......	340	420	535	610	675	780	870	970	1,050	1.10
25	......	......	......	......	......	376	470	580	655	755	835	950	1,050	1,150	1.11
26	......	......	......	......	......	405	505	610	700	810	925	1,040	1,150	1,240	1.11
27	......	......	......	......	......	450	545	665	770	900	1,010	1,130	1,250	1,330	1.12
28	......	......	......	......	......	......	600	710	835	980	1,080	1,215	1,330	1,470	1.13
29	......	......	......	......	......	......	630	770	880	1,050	1,170	1,310	1,440	1,580	1.13
30	......	......	......	......	......	......	......	810	970	1,135	1,230	1,400	1,560	1,730	1.14
31	......	......	......	......	......	......	......	880	1,040	1,200	1,345	1,510	1,690	1,820	1.14
32	......	......	......	......	......	......	......	950	1,110	1,300	1,450	1,615	1,770	1,940	1.15
33	......	......	......	......	......	......	......	1,025	1,190	1,360	1,530	1,700	1,870	2,060	1.15
34	......	......	......	......	......	......	......	1,100	1,260	1,445	1,600	1,840	2,000	2,200	1.16
35	......	......	......	......	......	......	......	1,135	1,320	1,510	1,710	1,945	2,110	2,300	1.16
36	......	......	......	......	......	......	......	1.195	1,410	1.610	1.845	2,030	2,260	2,510	1.17

Computation by T. S. Hansen.

comparing the three species increase in d.b.h. is taken to denote increase in age. This is not entirely true, but it is sufficiently so for this purpose. Figure 1 gives the three curves all plotted together.

The curves have been discussed separately and reasons for their trend advanced. In comparing the three species, we find that in the younger trees white pine has the smallest relative volume, while jack pine has the greatest. In all three species there is a point of greatest relative volume followed by a decrease. The maximum relative volume occurs at a comparatively smaller size and in younger aged trees in jack pine than it does in either of the other two. The rapid fall in relative volume accompanied by the increase in taper indicates a decline in the vigor of the tree. This shows that jack pine reaches its maturity earlier and falls off more rapidly than the other two. White pine and Norway pine reach the point of maximum relative volume at the same time, but white pine holds it longer than the Norway pine. The relative volume of the Norway pine is at all times greater than that of white pine, showing the rate of taper to be less in Norway than in white. In other words, the shape of the Norway bole approaches a paraboloid in practically all of the sizes, while white pine is both a paraboloid and neiloid.

The following figure adds to the above mentioned curves those based on the taper tables. These curves give an entirely different aspect to the form of the tree. This may be due to the averaging of a great many trees having a tendency to even off any irregularities. Further work is necessary on this point as tables constructed on both tree measurements and taper measurements show themselves to be sufficiently accurate.

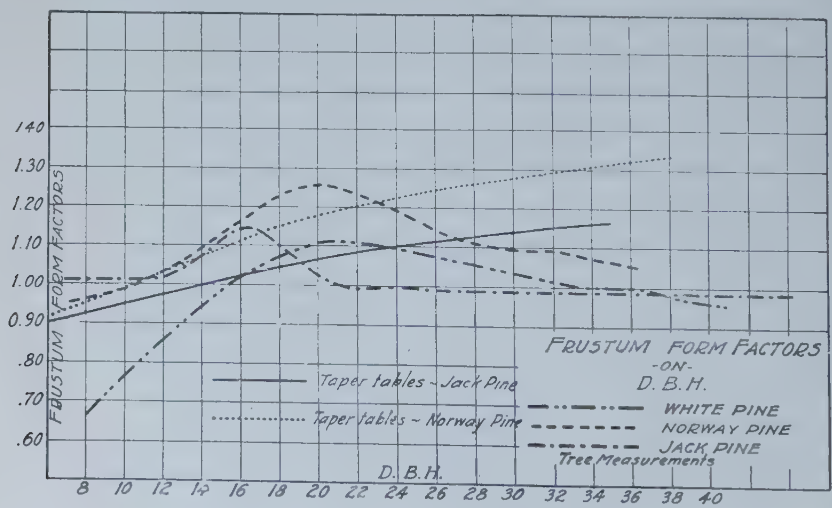

TABLE 6.—*Volumes of Frustums of Cones.*

Scribner Decimal C scaled to nearest 0.1 inch. Top diameter, 6 inches. [Height 16-foot logs.]

D.B.H.	½	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7
7	5	20	28	40	......	......	......	......	......	......	......	......	......	......
8	5	20	32	50	......	......	......	......	......	......	......	......	......	......
9	......	20	35	50	61	80	......	......	......	......	......	......	......	......
10	......	20	35	50	65	86	101	......	......	......	......	......	......	......
11	......	20	35	55	75	98	116	138	......	......	......	......	......	......
12	......	......	35	60	87	110	133	155	......	......	......	......	......	......
13	......	......	39	70	97	121	145	174	198	226	......	......	......	......
14	......	......	......	80	103	130	160	190	219	250	280	......	......	......
15	......	......	......	86	109	140	189	214	245	278	313	340	......	......
16	......	......	......	......	115	162	200	230	267	300	343	382	......	......
17	......	......	......	......	130	177	212	253	290	342	385	426	......	......
18	......	......	......	......	141	190	241	280	345	376	415	460	511	......
19	......	......	......	......	151	215	257	312	362	404	459	515	565	......
20	......	......	......	......	165	235	275	340	388	442	511	567	620	......
21	......	......	......	......	185	250	298	370	425	500	563	615	673	770
22	......	......	......	......	......	268	318	400	470	538	610	671	748	824
23	......	......	......	......	......	285	355	438	507	592	650	735	817	884
24	......	......	......	......	......	310	381	485	555	642	706	790	879	946
25	......	......	......	......	......	339	422	524	590	678	754	855	949	1,029
26	......	......	......	......	......	366	457	550	630	730	832	937	1,034	1,118
27	......	......	......	......	......	400	485	586	686	805	904	1,010	1,116	1,190
28	......	......	......	......	......	......	530	630	740	858	955	1,075	1,179	1,301
29	......	......	......	......	......	......	559	678	778	926	1,034	1,160	1,271	1,400
30	......	......	......	......	......	......	......	710	850	996	1,098	1,230	1,366	1,514
31	......	......	......	......	......	......	......	771	914	1,050	1,178	1,325	1,482	1,591
32	......	......	......	......	......	......	......	824	963	1,128	1,258	1,401	1,535	1,685
33	......	......	......	......	......	......	......	889	1,035	1,182	1,332	1,480	1,628	1,783
34	......	......	......	......	......	......	......	950	1,085	1 244	1,380	1,585	1,724	1,890
35	......	......	......	......	......	......	......	986	1,134	1,300	1,473	1,676	1,830	2,007
36	......	......	......	......	......	......	......	1,020	1,206	1,370	1,576	1,760	1,933	2,124

TABLE 7.—*Volumes of Frustums of Cones.*

Scribner Decimal C scaled to nearest 0.1 inch. Top diameter, 7 inches. [Height 16-foot logs.]

D.B.H.	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½
8	60	70	90	....	....	....	....	....	....	....	....	....
9	60	72	94	105	126	....	....	....	....	....	....	....
10	66	78	100	117	141	155	....	....	....	....	....	....
11	70	88	118	136	160	179	....	....	....	....	....	....
12	84	100	132	150	181	202	....	....	....	....	....	....
13	90	109	140	165	200	221	254	....	....	....	....	....
14	95	116	152	180	222	247	284	319	....	....	....	....
15	....	124	168	200	240	270	310	346	....	....	....	....
16	....	136	190	215	257	290	338	387	....	....	....	....
17	....	150	199	232	285	336	380	420	463	....	....	....
18	....	160	215	257	318	361	410	450	527	....	....	....
19	....	174	240	287	350	386	444	496	560	....	....	....
20	....	196	255	318	370	417	493	529	609	660	....	....
21	....	214	272	330	396	461	542	596	664	722	....	....
22	....	....	290	359	439	501	590	643	727	800	....	....
23	....	....	319	387	480	548	640	706	799	866	....	....
24	....	....	341	418	514	592	680	756	853	929	1,020	....
25	....	....	370	466	552	630	713	819	920	1,000	1,115	....
26	....	....	....	496	581	672	807	890	1,000	1,085	1,200	....
27	....	....	....	524	620	736	860	952	1 057	1,151	1,279	....
28	....	....	....	560	676	787	910	1,018	1,129	1 249	1,380	....
29	....	....	....	....	718	831	980	1,090	1,226	1,335	1,489	....
30	....	....	....	....	759	919	1,060	1,160	1,318	1,451	1,582	....
31	....	....	....	....	830	996	1,102	1,245	1,410	1,531	1,659	....
32	....	....	....	....	872	1,022	1,170	1,318	1,470	1,609	1,759	....
33	....	....	....	....	930	1,090	1,237	1,384	1,554	1,700	1,874	....
34	....	....	....	....	980	1,143	1,304	1,450	1,644	1,787	1,989	....
35	....	....	....	....	1,020	1,202	1,362	1,601	1,747	1,912	2,120	....
36	....	....	....	....	1,056	1,266	1,462	1,657	1,823	1,998	2,201	....
37	....	....	....	....	1,120	1,319	1,540	1,731	1,910	2,096	2,292	....
38	....	....	....	....	1,173	1,382	1,601	1,815	2,004	2,169	2,435	....
39	....	....	....	....	1,244	1,442	1,675	1,912	2,057	2,252	2,515	....
40	....	....	....	....	1,286	1,514	1,748	1,940	2,160	2,425	2,647	....

A NEW HYBRID PINE

(*Pinus palustris* × *Pinus taeda*)

By H. H. Chapman

In 1915, V. H. Sonderegger, then employed with the Mansfield Hardwood Lumber Company in Winn Parish, northwestern Louisiana, and now State Forester of Louisiana, discovered a pine, the characteristics of which indicated that it was a hybrid of longleaf pine (*Pinus palustris*) and loblolly pine (*Pinus taeda*). The occurrence of this hybrid extended southward into LaSalle Parish and it has since been observed at many widely separated points, as far southwest as Lake Charles in Calcasieu Parish.

About the same time, the seedling stage of the pine was observed and differentiated from longleaf and loblolly pines by Ranger Wm. Thompson of the State Conservation Department. Sonderegger stated that the hybrid occurred frequently in Winn, Sabine, and Vernon Parishes.

The attention of the writer was first called to this pine in 1920 when two specimens, previously noted by R. D. Forbes and W. R. Mattoon, were pointed out on the Roberts experimental plot of the U. S. Forest Service at Urania, La., it being thought at that time by Henry Hardtner that they were slash pines (*Pinus heterophylla,* since renamed *Pinus caribaea*). To this claim, Mr. Sonderegger took exception, stating that it was undoubtedly a hybrid between longleaf and loblolly. The range, also, was several hundred miles distant from the nearest known slash pine.

In the spring of 1922, a re-examination was made of some reproduction plots at Urania, La., abundantly stocked with longleaf pine reproduction. Here numerous scattered specimens of the hybrid were found, averaging one to three or more per acre. It was possible in every instance to easily distinguish this hybrid from either longleaf or loblolly. The pines were from 4 to 20 feet high and had originated since 1913. Finally, in counting seedlings of the 1921 and 1922 crops of longleaf pine on these plots, those of the hybrid were observed and

could be as easily distinguished from the parent species as were the saplings.[1]

A closer study was then made resulting in the following findings:

1. The seed appears to originate from longleaf seed trees; so that the male parent is probably the loblolly. None were found except near longleaf trees bearing cones, and except where other seedings of longleaf were found.

2. The seed evidently germinates at the time of longleaf seed germination; i. e., in the late fall, and the seedling establishes itself during the winter instead of the spring as does loblolly pine.

3. The embryonic foliage of the seedling is from 1 to 2 inches long, resembling longleaf seedlings; while that of loblolly is about one-half inch long and much finer.

4. The seedling by spring of the same season, i. e., in April after the fall of the seed, develops a stalk from 1 up to 2 inches in length. Even the most vigorous longleaf seedlings of this age develop no stalk whatever in the first two years and commonly not for five seasons. This shows the influence of the loblolly parent.

5. The sapling develops foliage whose needles measure from 9 to 14 inches in length, averaging 10 to 11 inches. This character is constant. Some of the more vigorous specimens have needles exceeding in length

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NOTE.—More recent notes by V. H. Sonderegger are of interest in connection with the distribution of this pine:

"While at summer school this summer, we went over to the Tremont Company's holdings and we found a 60 per cent stand of this, intermingled with the loblolly and longleaf near the edge of the Dugdamonia swamp. This is where I first noticed this species years ago and will state that the virgin timber we found there averaged 16 to 20 inches in diameter and is known to the local people in that section as rosemary longleaf. Above Joyce, Mr. Pate, manager of the Tremont Naval Stores, told me that they were turpentining this species and the result was that they were getting three cups of gum against one cup of longleaf. He told me that he thought it was slash pine but later on admitted his mistake and adopted the expression of the natives who called this betwixt and between. We have found this species not only at Urania but also at Winnfield (Winn Parish) and in and around Castor (Bienville Parish). Mr. Thompson reports that this hybrid is also scattered through Rapides and Allen Parishes. A peculiar specimen was sent to me from Bienville Parish, a cluster of four cones at right angles to each other that is, in the shape of a cross. I have seen cones in pairs and triples but this is the first time I have noticed cones in a group of four, making a cross."

less vigorous longleaf seedlings. No loblolly needles were found exceeding 9 inches in length.

6. The bud and the annual shoot and the needles are intermediate in size and appearance between longleaf and loblolly pines.

7. The seedling makes most of its growth in one shoot, but commonly produces a second growth or shoot 3 to 4 inches long in the same season. Longleaf seldom if ever produces a second shoot, while loblolly nearly always does and on old fields of vigorous trees produces three growths in a season.

8. The branching habit of the pine distinctly departs from that of longleaf with its characteristic absence of whorls, and develops at least three branches at the end of the main shoot of the previous year, for each season. Yet these branches are not so persistent as those of loblolly and grow less vigorously, probably falling off sooner so that the pine will clear itself more in the manner of longleaf later on.

9. The leaf bases on the hybrid are raised, protruding one-tenth inch from stem in the first year after the leaves fall, and are retained for 3 or 4 years after the manner of longleaf. They are five-tenths to six-tenths inch long, but do not have the membraneous or woolly bracts persistent as do longleaf twigs; thus resembling loblolly. The base project less sharply than on longleaf; the point of attachment of needles is less deeply indented. The bases or scales have a less pronounced keel, or are flatter than longleaf, blunter, slightly broader, and less numerous in cross section. Loblolly leaf bases are raised hardly at all, the twig being practically smooth, while the base scales are thin, papery and deciduous at about the second year after the leaves fall, are two-tenths inch at apex or less and taper to a wedge shaped point.

10. The growth of the seedling in its second season is about 1 to 2 inches in height. In its third season, it grows from 6 to 18 inches, and from then on height growth is rapid. In this respect it is intermediate between loblolly and longleaf pine.

11. The hybrid pine grows more rapidly than the longleaf pine. Two trees which had apparently come from the 1913 seed crop of longleaf showed the following comparative dimensions in 1922:

	Hybrid	*Longleaf*
Total height	13′ 4″	2′ 11″
Diameter inside bark 1 foot from ground	2.3″	.6″
Bark thickness	.45″	.35″

12. The cones are intermediate between longleaf and loblolly pine in all respects. Their size, from three specimens obtained in Bienville Parish, varies from 5 to 6 inches in length, exceeding 1.5 inches in width when closed, and exceeding 3 inches in width when opened. The prickles are not recurved like longleaf, but pointed outward like some loblolly cones. The exposed ends of the scales are not as corrugated with stripes in small ridges running parallel with axis of cone as the longleaf, but are smoother or halfway between the longleaf and smoother surfaces of the loblolly cone. Longleaf cones resemble it in shape more than do loblolly, but vary from 6 to 10 inches in length and from 2.4 to 3 inches in width closed; while loblolly vary from 5 down to 3 inches in length, and from 1.2 to 1.5 inches in width closed.

13. Professor R. S. Cocks of Tulane University, from specimens sent him by Mr. Sonderegger, states that the leaf and wood structure are those of *Pinus taeda.* Larger specimens are recorded near Lake Charles, Calcasieu Parish (R. D. Forbes), and north of Saline, Bienville Parish (Wm. Thompson), in T. 15 N., R. 5 W., N. La. M., the latter being 10 inches d. b. h., about 25 years old, and growing rapidly, bearing a number of cones.

All the specimens found exceeded the longleaf seedlings with which they were growing, both in height and diameter, being from 4 to 18 feet high as against 6 inches to 8 feet for longleaf pine.

The hybrid is more fire resistant, apparently, than loblolly pine, as its bark in thickness and texture seems to greatly resemble longleaf pine, though in appearance, on account of the leaf bases, it is midway between the two pines.

In one case where a sapling was found on land grazed by hogs, the hogs had peeled the bark from several small laterals, but had done the same with a shortleaf pine adjoining. It cannot be stated to what degree the roots of this hybrid are attractive to hogs, but several other saplings were found surviving on land heavily hog grazed and on which all longleaf saplings and seedlings had been destroyed by the hogs.

This hybrid is said by Sonderegger to possess in a high degree the capacity to yield naval stores, similar to the longleaf parent. It also resembles the latter in being subject, in its juvenile stage, to the attack of a defoliating rust (*Septoria pinus*), which affects longleaf pine seriously, but apparently does not damage loblolly pine.

As far as observed by the writer, the hybridization occurs only on cut-over lands which originally bore heavy pure stands of longleaf pine,

and which now have a few scattered seed trees left. It occurs only on dry sites, and only where loblolly pines are growing near enough by, in low places, to distribute their pollen over the area. In some instances longleaf, loblolly, and hybrid seedlings were all found within the same square rod, while elsewhere only the longleaf and hybrid seedlings occurred. In one spot five hybrids were found, which might have sprung from seed shed by a single cross-fertilized cone on a nearby longleaf tree.

The cones of this pine evidently produce fully developed seed. Whether this seed is fertile, and what will be the character of the resultant seedlings is not yet determined.

Owing to the period required to grow a generation of trees to the stage of seed production, experiments in breeding new strains of trees have been undertaken largely in horticulture, rather than in forestry. With pines, the difficulty of perpetuating a desirable hybrid would be found in the cross fertilization by the original parent species resulting in reversions to the parental type. This influence is probably the cause of the apparent failure of the hybrid to establish itself under natural conditions as a species or variety. Since, in southern pines, natural reproduction must be relied on largely, the success of attempting to artificially propagate this cross and breed true to type is problematical.

But the idea of developing this new species of pine by plant breeding methods is worth serious thought. The greatest continuous area of denuded land, of doubtful agricultural value, in the United States is the belt of cut-over longleaf pine lands. When the seed trees are destroyed, artificial reproduction is the only hope of reforesting these soils. Longleaf pine has a pronounced taproot, takes five years to start its height growth and grows slowly in diameter, but is resistant to drought and fire and adapted to these soils. It is, however, exterminated by uncontrolled hog grazing. Loblolly pine is not damaged by hogs, but is exceedingly susceptible to damage by fire, and is sensitive to drought, not doing well on typical longleaf lands. Cuban or slash pine may grow considerably north of its present range and on soils other than its natural sites, but this possibility is not yet fully shown. The hybrid pine apparently grows well on longleaf land, exceeding greatly the height and diameter growth of longleaf as a seedling and sapling and probably throughout its life. It will resist fire, not so well as the longleaf but better than loblolly. It is not so subject to hog

damage as longleaf, and might survive hog grazing if not too severe—and it is said to produce naval stores.

The hugeness of the task ahead in reforesting this tremendous area should stimulate foresters to seek the aid of all agencies which may help in its accomplishment. The seed of the hybrid pine, obtained from several localities, planted in some district outside the present longleaf pine belt to present later cross fertilization, and the development of a variety by selection and elimination of undesirable variants, is an experiment which might in time yield a source of seed for plantations of this new strain and be of great benefit to the South and to forestry.

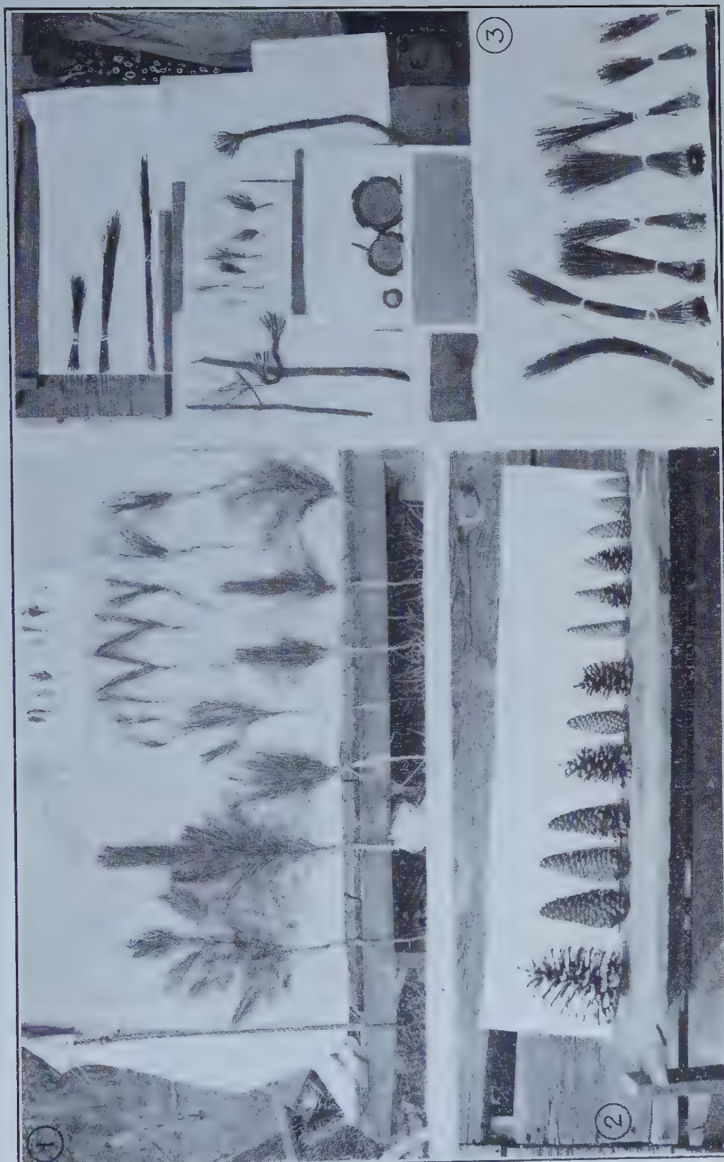
Should it be necessary in the future to give this hybrid a name, that of *"Pinus Sondereggeri"* is suggested, since, as far as can be determined, Mr. Sonderegger was the first to recognize its distinct botanical character, and identity.

Legends for Plate I, Figures 1, 2, and 3.

Fig. 1.—Seedlings, from left to right. Bottom row, (1) Pinus taeda, 4 years old; (2) Pinus sondereggeri, 4 years old; (3) Pinus palustris, 4 years old; (4) Pinus taeda, 4 years old; (5, 6) Pinus sondereggeri, 3 years old; (7) Pinus palustris, 3 years old. Second row, (1, 2, 3) Pinus taeda, 2 years old; (4, 5, 6) Pinus sondereggeri, 2 years old; (7, 8) Pinus palustris, 2 years old. Third row, (1, 2) Pinus taeda, 1 year old; (3, 4) Pinus sondereggeri, 1 year old; (5, 6) Pinus palustris, 1 year old; (7) Pinus taeda, 1 year old; (8, 9) Pinus sondereggeri, 1 year old; (10) Pinus palustris, 1 year old.

Fig. 2.—Cones. From left to right. (1 to 4) Pinus palustris; (5 to 7) Pinus sondereggeri; (8 to 13) Pinus taeda.

Fig. 3.—Needles. Upper sheet, above, Pinus taeda; middle, Pinus sondereggeri; lower, Pinus palustris. Lower sheet, left to right, (1, 2) Pinus palustris; (3 to 7) Pinus sondereggeri; (8) Pinus taeda. Wood Cross Sections, left, Pinus palustris; middle, Pinus sondereggeri; right, Pinus taeda. Seedlings, 1 year old, left, (1, 2) Pinus taeda; middle (3, 4) Pinus sondereggeri; right (5, 6) Pinus palustris.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PRELIMINARY RESULTS WITH EXOTIC FOREST TREES AT MONT ALTO, PENNSYLVANIA

By George S. Perry

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Experimental investigation is always highly desirable, and in the formative period of any art or science it is absolutely necessary. This fact prompted the Pennsylvania Department of Forestry at an early date to grow exotic trees in its nurseries and establish them in forest plantations. The difficulty of purchasing seed of native species, other than white pine, also favored or possibly even forced this policy. Hence, among the early plantings made near the State Forest Academy there are many examples of exotic trees growing under forest conditions. As a guide to future commercial and experimental planters in Pennsylvania, hereinafter are set forth the results to date with exotic forest trees both in the forest nursery and in plantations.

For the purpose of this discussion an exotic tree will be considered as any species not native to Pennsylvania. Wherever growth measurements are given they are based on 25 to 100 specimens located as a temporary sample plot in a representative part of the plantation.

Scotch Pine (Pinus sylvestris):

The oldest planting of Scotch pine was made in 1909, when 34,000 two-year-old seedlings from the Mont Alto Nursery were planted on a very sterile area near Pond Bank, composed of abandoned farm land partly covered with mine refuse from "stripping" iron ore. These trees seemed to find a very congenial habitat upon this ferruginous sandy soil, as attested by the following growth data collected in December, 1921: Age of trees, 15 years; average total height, 21.25 feet; average diameter, breast-high, in 1921, 3.28 inches; average annual height growth, 1.63 feet; average height growth (1921), 1.37 feet.

From this it will be noted that height growth has apparently passed its maximum. This is mainly due to the inclusion of suppressed individuals in the totals. Spacing was close—about 4½ by 4½ feet—and practically all these trees are still present. The largest trees

exceed 30 feet in height and made a current growth of 3 feet. Calculation shows that this plantation will now yield almost 12 cords of wood per acre, utilizing to a top diameter of 2 inches outside of bark. This approximates closely the "cord per acre per year" ideal, and certainly strongly indicates the value of Scotch pine for reforestation work upon denuded areas of sterile sandy surface or subsoil.

A very satisfactory stand of Scotch pine is growing on an inundation area with gravelly substratum near Caledonia Park on the Lincoln Highway. While this last site differs markedly from the first in most respects, it is similar in being free of shrubby or tree growth, so that the pine developed without competition in either soil or air.

Where Scotch pine is planted on burned-over areas or so-called "scrub-oak land," it fails to do nearly so well as in the instances above cited. Huckleberry brush, sweet fern, bracken, laurel, and the aggressive oaks hold it in check. Even when these weed species are cut back their roots still prevent the pine from making the good showing it does in the open. But no native or exotic conifer has yet been found capable of sustained vigorous growth on such sites here at Mont Alto, and this one promises as well as any yet tried.

Scotch pine has suffered from no serious enemies as yet. Snow pressure in plantations has done some injury, but wider spacing should eliminate this trouble. It lends itself very readily to nursery practice, surpassing every member of the genus *Pinus* in this respect. Like all "hard pines," it must be planted out in the forest at the age of two years, or else transplanted in the nursery at 1 or 2 year intervals, if larger stock is desired.

Bank's or Jack Pine (Pinus banksiana):

The first field plantings of this tree were made only three seasons ago, but the trees average two feet tall, and now (May 1, 1922) bear numerous pistillate flowers and a few 1-year-old cones. It will probably exceed Scotch pine in rapidity of juvenile growth on all sites, and especially on very sterile, dry situations. It approaches Scotch pine in ease of nursery propagation, but requires a little more care during the first two months after germination. As a seedling, jack pine is not easily distinguished from pitch pine when growing in the seed beds, due to its secondary foliage being much longer on small seedlings than on older specimens. Some trees show three needles to a cluster instead of two the normal number.

Pinon or Nut Pine (Pinus edulis):

This tree has been growing in the Mont Alto Nursery for five years, and has also been planted out nearby in competition with the native hardwood growth. It averages now only 1 foot in height, but has proved entirely frost-hardy and carries prickly foliage of an attractive blue-green hue. These sharp-pointed needles should stand it in good stead as a defense against damage from deer, a trouble from which both the Scotch pine and jack pine have suffered considerably.

Lodgepole Pine (Pinus contorta):

This tree can be grown in the nursery about as easily as Bank's pine, which it resembles closely in youth. Field plantings were made about Mont Alto following the removal of blighted chestnut, and show a high per cent of establishment, but they have as yet had only one growing season since being set out as 2-year-old seedlings, and no definite forecast can be based upon their present fair promise.

Western Yellow Pine (Pinus ponderosa):

A plantation of this tree made in 1908 on a sandy-loam area in an open field, grew until April, 1919, when most of the trees were destroyed by fire. The few individuals that escaped suffered considerably. At the time of the fire these trees showed an average height slightly above 8 feet. Now, at the end of 14 seasons in the field, the few remaining trees average 11.2 feet in height and appear to be declining in thrift, either due to the effects of fire or a needle rust which is quite prevalent.

Western yellow pine does not establish itself so well as other pines when transplanted, but from the above early growth is seen to be fairly good. Where this tree was planted after the lumbering of the blighted chestnut, it has done little more than barely maintain itself. It is rather easily raised in the nursery unless adverse soil and weather favor development of "damping off" fungi, then nearly all the tender seedlings in a bed may be lost in a few days. Our experience with this tree will not permit either praise or condemnation, but for general forest planting many other hard pines show greater adaptability to the tree growth conditions of the eastern United States, if results at Mont Alto may be considered indicative of what the tree will do elsewhere.

Asiatic Stone Pines (Pinus Armandi and P. Koreensis):

These two pines have been grown experimentally in the Mont Alto nursery during the past 5 years. They have been uniformly difficult to protect from rodents, tardy, and irregular in germination, and very slow in growth. Both species suffer from climatic and general insect inroads which caused steady dwindling during their nursery life. While they may be desirable introductions from the standpoint of wild-life conservation and sustenance, or æsthetics, it is doubtful whether either can find congenial sites and growing conditions in Pennsylvania.

Maritime Pine (Pinus pinaster):

Two pounds of the seed of this species were sown in the nursery in June, 1918. Germination was prompt and growth rapid during the first summer. It was also surprising to note the degree of frost-resistance evinced by many of the seedlings. About 5 per cent survived through two winters, although with their growing tips somewhat injured. The tree is obviously unsuited to the climate of Pennsylvania, but should be a very valuable addition to the forest flora of the South Atlantic and Gulf Coastal Plain, judging by its ease of propagation and rapid seedling growth.

Japanese Red Pine (Pinus densiflora):

This pine and the Japanese black pine have been growing under observation in and near Mont Alto Nursery for the past 7 years. About 50 specimens of each species were planted out in the forest in competition with a mixed growth of native hardwood sprouts, hard pines, and briars. The largest red pines have been growing under these rather adverse conditions for 5 years and now average 8.2 feet in height. They are thrifty and promise results equal or exceeding those made by Scotch pine. They have already borne seed that was apparently viable upon ocular inspection. Frost in late spring has injured this tree slightly, but it quickly recovers. A saw-fly (*Lophryus leconte*) attacks it rather frequently, but it also injures Scotch pine, jack pine, and other similar exotics more seriously than it does the native hard pines.

Japanese Black Pine (Pinus thunbergii):

Except aesthetically and in the ease of nursery handling Japanese black pine is in every way slightly inferior to Japanese red pine. Both approach Scotch pine closely in adaptability to nursery prac-

tices. The long stiff needles of the black pine subject it to injury from snow at a very early age, but their acute tips guard the large silvery buds against squirrels, deer and grazing stock. Winter cold as well as late frosts damage it slightly.

Austrian or European Black Pine (Pinus austriaca):

No plantations of this tree have been made about Mont Alto, but ornamental specimens grow vigorously and seem proof against all organic and climatic sources of injury. In the nursery this tree reacts just about like western yellow pine.

European Larch (Larix decidua):

European larch requires a fresh soil of fair to good natural fertility, but the plantations about Mont Alto are on dry sandy sites. The oldest was made in 1909 in mixture with Scotch pine and has suffered somewhat in the struggle with this aggressive species, but measurements at the end of the thirteenth growing season show: Average total height, 19 feet; maximum total height, 26.8 feet; average annual height growth, 1.46 feet; average 1921 height growth, 2.66 feet.

This larch has also shown considerable ability to withstand shade during early life and recover after suppression. In 1916 a small planting was made under a stand of blighted chestnut poles mixed with oaks. For 3 or 4 years these trees made only nominal growth, but very few died; then in the spring of 1919 the chestnut was cut off the area and the overstory of oak thinned, so the crown canopy was reduced to a density of about 25 per cent. This gave the larch trees an opportunity to grow and during the past three seasons their total height growth averaged more than two feet. A needle-rust occurs commonly upon trees growing on dry sites, but even with this handicap such trees continue to put on satisfactory height increment.

Japanese Larch (Larix leptolepis):

Only a few specimens of this larch are growing at Mont Alto under forest conditions, but they promise equally as well or better than the preceding species, especially on rather dry sites. Both trees are easily grown in the nursery, often attaining a height of more than 3 feet at the end of their second growing season. Both suffer from late frosts in spring if the temperature falls below 24° Fahrenheit, but the Japanese larch is probably most sensitive, as can be

readily noticed in the nursery beds if frost occurs at the beginning of the second growing season. This resistance of the European larch at that time is, however, chiefly due to its retention of a large part of its foliage during the first winter, thereby protecting the tender new needles. The Japanese larch carries a denser crown than its European relative and will probably maintain better forest conditions. It is also apparently less subject to needle-rust. Foresters who have had experience with Japanese larch in southeastern Pennsylvania look upon it with high favor, which seems entirely justified by results here to date.

White Spruce (Picea canadensis):

White spruce is not native to Pennsylvania, but should find favorable growing conditions in the mountainous central and northern parts of the State. It is not quite as easily grown in the Mont Alto Nursery as Norway spruce and is more severely injured by frosts in late April. Its earlier vernation is a drawback, but extreme tolerance of shade and crowding count in its favor. Two small plantings occur at Mont Alto; one under heavy shade, the other competing with brush. Norway is mixed on both sites, but is losing out to maples and other hardwoods, while the white spruce is quite thrifty and slowly increases its height increment from year to year.

Sitka Spruce (Picea sitchensis):

Sitka spruce grows more rapidly than Norway spruce in nursery seed beds. It can be produced with as great facility as this species and is probably more tolerant. We have had only three seasons' experience with Sitka spruce, but note no damage from any source except some browning of the needles by winter cold. This trouble is more of an æsthetic than actual disadvantage to the tree, since it recovers rapidly. Recently made plantations will be watched with interest. They are located in a cool moist mountain valley under a broken overwood of hemlock, white pine and hardwoods. Nursery observations indicate that ample soil moisture is necessary to the tree's well-being.

Engelmann Spruce (Picea engelmannii):

Three years ago an effort was made to grow this tree, but it seems to be poorly adapted to our standards of nursery practice in Pennsylvania. A few sickly (2-1) transplants are all that remain from sowing a pound of seed in 1919.

Colorado Blue Spruce (Picea pungens):

Colorado blue spruce is readily grown in the nursery and easy to transplant. We have no experience with it in forest planting, but judge that it is more exacting than Norway spruce as to soil moisture and fertility, as this has been found true in the nursery. It grows about half as fast as this latter tree and surpasses it in being perfectly frost-proof. It is rather intolerant of shade, as may be proven by comparison of seedling growth in the middle and along the margins of beds.

Norway Spruce (Picea abies):

Norway spruce serves as a sort of "silvicultural yard-stick" which foresters may use as a standard for the performance of other members of the same genus. It not only has a weighty place in the forestry literature of the Old World, but is one of the most generally planted trees of the northeastern United States.

The earliest plantings of this tree were made on the Mont Alto State Forest in 1908 and 1909 with 2-year-old seedlings. They succeeded poorly, and made slow growth for many years. Part of the 1909 planting was under a rather heavy canopy of short-leaf and pitch pines upon a medium quality sandy loam. The overstory of pine was of large pole size and was windthrown in the spring of 1918 which liberated the spruce. Until this time the spruce had been barely able to survive, but now quickly recovered, and in December, 1921, showed an average total height of 7.4 feet and maximum of 11.2 feet. The 1921 height increment was 1.56 feet compared to a mean annual height growth of .57 feet. The story of this planting indicates the value of the species for medium soil sites and illustrates the best method of introducing it upon a forest area.

In 1910 a mixed plantation of white pine and Norway spruce was established on an open field of poor sandy loam and gravel near Pond Bank. In the autumn of 1921 these trees showed: Average total height, 10.6 feet; height growth (1921), 2.1 feet; mean annual height increment, .88 foot.

This data demonstrates the persistent vigor of Norway spruce and the characteristic slow growth for several years after planting in the forest followed by a sustained steady increase. On this area the spruce is now nearly as tall as the white pine, and growing at about the same rate. It seems safe to recommend this tree for farm-woodlot planting and general forestry on sites of fair quality. Its

dense foliage in youth affords game and small birds a welcome haven of refuge in winter and gives it value for shelterbelt use, both around fields and farm-yards, and on the exposed margins of forest stands whose optimum increment depends upon the exclusion of hot sun and drying winds.

Norway spruce is very easy to grow and handle artificially. It suffers slightly from late spring frosts and leaders are at times attacked by a weevil, but it promises greater vigor and thrift under natural forest conditions than is usual with isolated ornamental specimens.

Douglas Fir (Pseudotsuga taxifolia):

Douglas fir has on the whole made a rather dismal record at Mont Alto. Regardless of seed origin it was more or less injured by winter cold. The earliest planting of the Rocky Mountain variety, which is fairly hardy, was made in 1914 on a dry, siliceous mountain soil under a low canopy of rock, scarlet and scrub oak, pitch pine, black gum, red maple, etc. Although liberated from shade in the early spring of 1918, these trees did not recover, but have since been nearly extinguished by the dense coppice and herbaceous growth that developed. Later planting on abandoned farm land shows some promise, but as it has grown only a single season, good establishment is about all that can be definitely said in its favor.

European Silver Fir (Abies pectinata):

European silver fir is beginning its third growing season in the nursery seed beds and cannot be recommended when judged by results to date. Germination was slow and irregular, frost heaving and injury in late spring serious, and rate of growth very slow. It demands a good supply of soil moisture and would likely be favored by a humid atmosphere. Adaptability to Pennsylvania forestry is questionable. It might grow fairly well on cool slopes and in moist valleys of our northern mountains, but spruces and the native hemlock would probably be equally desirable species there.

Chinese Arborvitæ (Thuja orientalis):

Chinese arborvitæ has been the most easily grown of all trees propagated in the Mont Alto nursery. It develops rapidly during early life and is very ornamental in appearance. It does not seem very tolerant and probably has little forestal value, unless it be for marginal planting around maturing stands to bar the entry of drying winds.

Kryptomeria (Cryptomeria japonica):

No coniferous tree ever grown in the Mont Alto Nursery made height growth during its first year equal to that of Kryptomeria. Its terminal shoots continued to elongate until stopped by killing frost late in October. Three standard beds (100 square feet) then inventoried 18,000 seedlings with an average height of 5 inches and a maximum of more than a foot. The following spring (1920) not a single tree out of all this number was alive! In the light of this experience we might dismiss this tree from further consideration, but it is so highly desirable from numerous standpoints that it is hoped a later effort may be made to grow it from seed secured in the coldest and driest part of its range. For humid localities to the south of Pennsylvania, Kryptomeria would seem to be a most promising exotic and deserve a thorough trial.

Eastern Catalpa (Catalpa bignonioides) and Hardy Catalpa (C. speciosa):

Both catalpas have been grown and planted at Mont Alto to a limited extent. They are easy to produce in the nursery, but the former is worthless in Pennsylvania except as an ornamental tree during its brief season of bloom.

The hardy species of the West suffers but slightly from frost and makes fairly rapid growth on soils of agricultural quality. The early plantings of this tree were made on exhausted farm-land of very meager natural fertility. On such an area planted in 1904 the trees now average 24.5 feet in height and 4.6 inches in diameter at breast height. They are growing rather slowly, but now show fairly good form and would cut some good posts.

California Walnut (Juglans californica):

The California walnut made greater height growth during its first year than any species ever grown in the nursery. But as may be surmised, it suffered seriously from winter cold. A "blight" or slime mold fungus attacked the root systems of many seedlings and killed at least 70 per cent during their first year.

Chinese Chestnut (Castanea mollissima):

In 1912 when the ravages of the chestnut bark disease began to be serious in Pennsylvania, a quantity of Chinese chestnuts were planted in the Mont Alto Nursery and some of the resulting seedlings were

later out-planted in the nearby forest. These trees have been repeatedly killed back to the ground by the bark disease and seem nearly as susceptible thereto as our native trees. A few hybrid specimens, from crossing the chincapin and Japanese chestnut, show much more resistance to this disease, but are by no means immune.

The preceding recital of results with exotic trees is not full enough to enable the making of definite decisions respecting their value, but it will have served its purpose if it stimulates interest in the subject and is a stepping stone to further investigation and observation.

BEAR CLOVER AND FOREST REPRODUCTION

By E. N. Munns

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The problem of the bear clover (*Chamaebatia foliolosa*) is one which enters decidedly into the establishment and growth of reproduction of the important coniferous tree species in California. Bear clover has been reported from many localities as being the cause of the failure of restocking, while in much of the virgin forest advance reproduction is largely absent because of the widespread occurrence of this plant. The rapidity of its rate of spread and the extent to which it is prevalent make it a problem of great moment on burns and cut-over lands in the Sierra region.

Very little study has been made of its rate of spread, method of propagation, and influence on tree reproduction. An intensive study of a plot in the Stanislaus Forest was initiated in 1911. The plot was re-examined in 1915, and again in 1921. Several interesting changes which have taken place on this area since it was established are considered here. The conclusions to be drawn from a single area, however, are obviously preliminary and subject to confirmation or modification as further studies are made.

The area involved was burned over by a summer fire in 1911. Prior to the fire the area supported a scattered stand of bear clover, with occasional dense patches, most of which were small and probably developed as a result of a fire during 1902, as shown by fire scars on the standing trees. Two plots were laid out on this burn, each an acre in extent. These plots are at an elevation of 3,000 feet, about the middle of the altitudinal range of the western yellow pine type, in which occurs some cedar and an occasional fir, the latter being confined to the moister sites and slopes. The soil throughout is a deep granitic loam, typical of the region. Both north and south slopes are represented, but as the south slope was reclaimed by brush to the almost entire exclusion of the bear clover, no division is made between them.

SPREAD AND ROTATION OF BEAR CLOVER

The reason for the absence of the bear clover from an area has been variously ascribed to soil desiccation by the plants already inhabiting the area, which excludes the species becoming established, and to the density of the overhead shade, which so cuts down the light that photosynthesis is impossible. It is believed, however, that while both of these conditions are operative, neither is responsible for the absence of bear clover, but that rather this is due to the presence of a dense and thick layer of litter, which has both a mechanical and chemical influence. This is shown by the fact that the species is usually present only as scattered individuals or stems in most of the virgin forest in its range where fire has occurred for a relatively long period, while where fire has occurred more recently the species is quite widespread and the stand made heavier. Further, on areas where the litter has been removed, the bear clover comes in as densely as it does on land cleared by fire.

Where the litter in the pine forests lies for a considerable period it becomes matted together from 2 to 8 inches in thickness, and in this stage is almost impenetrable by the shoots of bear clover. When several shoots start at once, the litter mass is lifted instead of penetrated. This results in lack of light and air, and the stem, thus unable to function, soon dies out. The ground fire, which is the common type of forest fire in the Sierra region, runs rapidly, but it consumes the litter and small growth and in that way clears the surface. In addition, the heat and gases liberated kill a large per cent of the needles on the lower branches of the trees in the stand, and this, augmenting the annual fall of dead needles, makes quite a heavy carpet the spring after the fire. Especially is this true near the base of the trees roughly within the periphery of the crowns. It requires from two to five years for the bear clover to become dense again through the spread of the underground stems and development of dormant seed. During this period the litter is being constantly added to trees, making it more difficult for the bear clover to advance. The scattered bear clover finds the heavy litter a well nigh impassable barrier about the base of the trees when it reaches them. However, a second fire occurring at this time, removes the litter near the base of the trees and permits the bear clover to encroach until it is at the base of the trees.

The chemical influence of litter is believed to be responsible for the gradual disappearance of the plant again from the area. As the litter

accumulates, the strength of the acids formed gradually increases until the acid reaction is strong enough to cause the death or possibly the dormancy of the underground stems. When this point is reached the stand begins gradually to thin out. Toxic conditions brought about by the plant, the accumulation of carbon dioxide in the upper soil, and shade probably assist in killing out the stand. How strong an acid concentration is necessary to kill or inhibit the growth of bear clover is not known at the present time, and it is believed that it requires about 20 years' accumulation of litter from the average tree. After a fire, the addition of the chemicals liberated relieves the acid condition of the soil again to such an extent that growth is stimulated.

SPREAD OF BEAR CLOVER

The bear clover or tarweed is a semi-shrubby plant of the rose family. A dense stand of it resembles, on a much smaller scale, a thicket of the common wild rose. The clover does not grow much over 18 inches in height, but a dense patch has a large number of individual stems, amounting in counted stands to as many as 104 per square foot. It is difficult to ascribe different degrees of density to such a stand, but a "dense" stand here includes over 40 stems to the square foot, while a "scattered" stand here has from 5 to 40 stems with an average around 20 to the foot. Less than 5 to the square foot is considered an "open." The degree to which the area was covered at the time of the fire in 1911 and subsequently is given in Table 1.

TABLE 1.—*Per Cent of Area Covered by Bear Clover.*

Stocking	1911	1915	1921
Open	68.2	20.8	20.8
Scattered	25.5	31.1	8.0
Dense	6.3	48.1	71.2

Thus only 20.8 per cent of the area originally free from bear clover remained free while 17.5 per cent, which originally had a scattered stand, thickened up and now supports a dense stand. This encroachment appears to be a constant one, the open giving way to the scattered and dense, and the scattered to the dense stand. Occasionally one finds a small patch noted at one time as being a scattered stand which has become open, but it is believed that this is due to faulty classification

and the personal equation and is not characteristic. Thus, since the fire occurred, the spread of the bear clover has been rapid and in ten years' time it has taken practically complete possession of the area. The area free from bear clover from the beginning is a small patch which lies between the trunks of a large dense group of trees.

ESTABLISHMENT OF TREE REPRODUCTION

Since 1911 considerable reproduction has become established in the area in spite of adverse conditions. It is of interest to note that in 10 years' time it is satisfactorily stocked with seedling growth. The time of this establishment is of importance and this is shown in Table 2:

TABLE 2.—*Changes and Reproduction in Bear Clover.*

Degree of stocking			Per cent of area covered by bear clover	Per cent of reproduction by degree of stocking	
1911	1915	1921		1911-1915	1916-1921
O	O	O	10.6	37.4	44 4
O	S	S	8 0	14 6	26.0
O	S	D	23.1	21.4	.4
O	D	D	26.5	2.4	....
S	O	O	10.2	19.4	29.2
S	D	D	15.3	4.8	0
D	D	D	6.3	0	0
Total per cent			100	100	100
Total trees established			...	294	216

O = "Open," S = "Scattered," D = "Dense."

The examination of this table shows that the seedlings come in the stand only where the area is free or nearly so from the bear clover and that seedling establishment, especially of the pines, generally precedes the invasion. Once the clover is firmly established, very little reproduction can get a foothold, as the clover is able to prevent successful establishment.

It is seen that 56.8 per cent of the reproduction in the first period and 73.6 per cent in the second became established in areas free from the plant, while an additional 36.0 per cent appeared in the first period and 26.0 per cent in the second where the bear clover is practically negligible. Thus in the open and on areas fairly free from the plant, occurs 92.8 per cent of the reproduction established the first period and 99.6 per cent of the reproduction in the second. The balance

apparently shows that reproduction does become established in bear clover, but in the first period all of the trees which became established did so during 1913, which was one of the few summers of record with frequent and abundant rainfall. Those established in the dense stand were all incense cedar (*Libocedrus decurrens*) and occur in the stand which is classed as becoming progressively heavier.

A further study, initiated on the Stanislaus National Forest in May, 1921, shows the survival and establishment on an area free from bear clover and on an area where the trees were in competition with an average stand of the plant ranging from medium to dense. The two areas were but a short distance apart on a southwest slope in the mixed type. The area free from bear clover had more overhead forest shade. The ground cover here consisted of Lupine, *Calochortus, Iris, Delphinium, Viola,* an occasional bush of *Ceanothus integerrimus,* and scattered clumps of grass. The areas were examined three times after the initial work and the results of the examination are given in Table 3:

TABLE 3.—*Tree Establishment in Bear Clover and Forest, 1921.*

Species	Bear clover	May 25		June 26		Sept. 3		Nov. 14		Per cent surviving June-Nov.
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	
Western yellow pine	Present	59	100	31	53.4	2	3.4	2	3.4	6.5
	Absent	65	100	33	50.7	10	15.6	10	15.6	30.3
Sugar pine	Present	21	100	11	52.4	2	9.5	1	4.7	9.1
	Absent	38	100	23	60.4	3	7.9	3	7.9	13.0
Incense cedar	Present	64	100	43	67.2	14	21.8	12	19.1	27.9
	Absent	78	100	55	70.4	9	11.7	9	11.7	16.4
White fir	Present	9	100	2	22.4	0	0	..	..	0
	Absent	16	100	7	43.7	2	12.5	2	12.5	28.5

(Missing trees omitted in per cent calculations.)

It is thus shown that the presence of bear clover does account for the failure of trees to become established. The initial loss during the early part of the growing season is the more serious, but the high mortality probably is due to the elimination of trees which are unable to penetrate the litter, the physically weak, the action of animal life of

one kind or another, and fungus attacks. These factors would be operative to a greater extent in the early part of the vegetative season than later, while the subsequent losses are probably due more to the deficient soil moisture and high transpiration rate of summer. The incense cedar shows to better advantage than the other trees because of the higher per cent becoming established in the bear clover, while in the pines the per cent surviving in the open was from 2 to 5 times as great as in bear clover. None of the firs in the bear clover survived, which is probably due to lack of germination and great difficulty experienced in finding the seedlings in the mass of vegetation.

On a basis of summer survival, from June to November, when the competition with clover is especially severe, the effect of the clover is the more noticeable. Thus while only 6.5 per cent of the yellow pine in the bear clover escaped, 30.3 per cent in the open survived; for sugar pine, the difference is 9.1 and 13.0 per cent; while the white fir suffered total loss in one case, and in the other 28.5 per cent survived. The incense cedar offers an interesting inversion, 16.4 per cent surviving in the open as against 27.9 per cent in the bear clover. It is not believed that this indicates that the bear clover is beneficial to the cedar, but that stronger seedlings are indicated, the weaker ones undergoing a more severe culling at the time of germination in the bear clover stand than in the open. The fact that a higher survival in the bear clover all the way through is indicated does show that cedar does not find the bear clover an insurmountable obstacle to establishment.

ROOT CHARACTERISTICS

That the cedar does establish itself liberally in the bear clover is of common report, for old sample plot data and reproduction studies in the Sierra region show a much higher per cent of cedar in bear clover than of the other species. This establishment and growth is in some measure due to the character of the cedar root system, for, unlike the pines, it early forms a very ramifying root system which spreads in all directions and becomes very fibrous in good soils; while the pine does not divide as freely and has not the exceedingly fibrous system characteristic of the cedar.

It may be noted that quite frequently the white fir (*Abies concolor*) becomes established in bear clover stands, though not to the extent that the cedar does. This is largely due to the formation of surface roots which get moisture from the very soil surface. In fact, quite often this surface root system lies in the humic matter between litter and soil.

Such establishment by the fir, however, is believed to occur only during seasons with summer rains frequent or heavy enough to keep this surface moist. Tided over the first season, the deeper roots are probably able to function enough the second to make growth possible. The character of the root system of representative pine, cedar and fir are shown in figure 1.

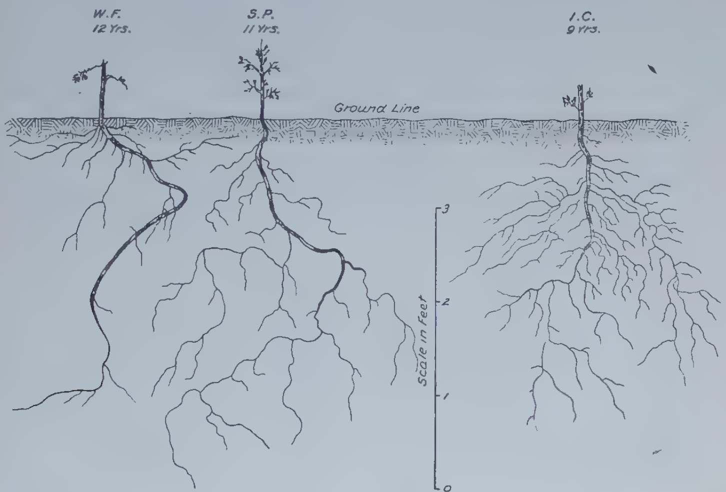

Fig. 1.—Root System of White Fir, Sugar Pine, and Incense Cedar in Competition with Bear Clover.

The bear clover has a great influence on the rate of growth of the reproduction it surrounds, largely due to the root competition between the young tree and the established plant. The bear clover extends its activities almost entirely by underground stems which push outward from the originating point, either an existing buried stem or individual plant, or from dormant seed stored either in the litter or humus layer. These underground stems are from .2 to .5 inch in diameter and spread along from 2 to 8 inches below the surface of the soil, and from these branches form at various angles appearing above the surface as the aerial part of the plant. The roots spread out from this stem both laterally and vertically, the laterals forming a rather loose network not more than six inches from the surface with feeders running down into the soil, while the vertical roots which run downward frequently also divide to form laterals. A mass of fibrous roots results which reaches a depth of four or five feet, the bulk of this fibrous root system occurring in the zone between 6 and 18 inches. It is these roots which

so drain the soil moisture that the young trees can not become established, or, when established, prevent it from rapid growth.

This drain on the soil is readily realized from figure 2, which gives

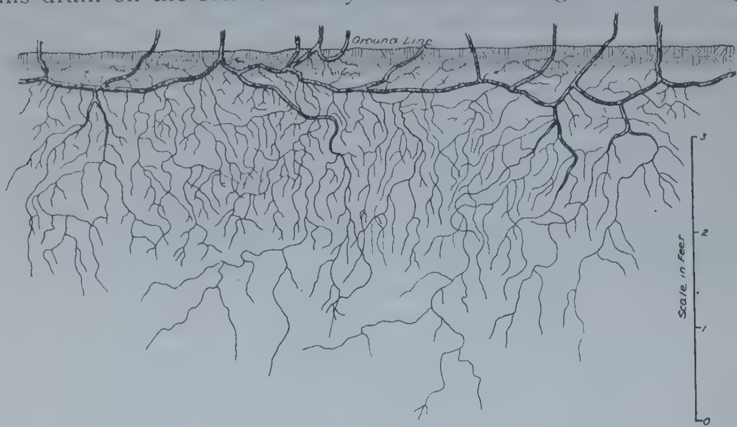

Fig. 2.—Root System of Part of Underground Stem of Bear Clover.

the characteristic root system of a section of the underground stem of the plant. One such stem was followed intact a distance of nearly 90 feet and it is not known to what distance these really extend. How completely the soil mass is permeated by these roots and the competition which other plants must meet is shown in figure 3, which presents a

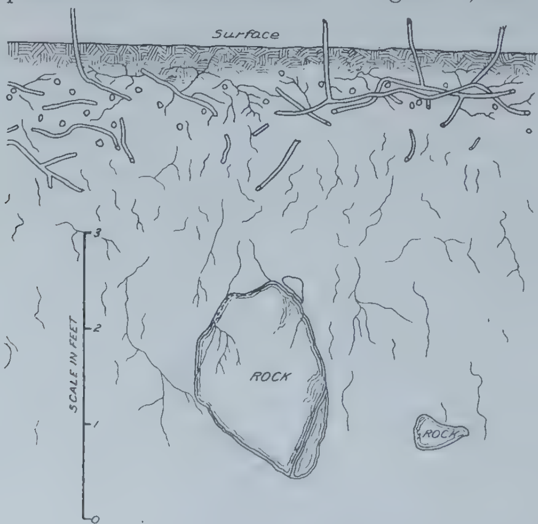

Fig. 3.—Bear Clover Root System in Profile (Vertical Cut) in Competition with Reproduction in Seedling Stage.

cross-section of a cut where there existed but a medium dense stand of bear clover.

RATE OF GROWTH OF REPRODUCTION

A number of stem analyses of seedlings and small saplings were made in the past few years of trees growing in bear clover and in the more or less open forest where bear clover was practically absent. As both studies were made in the same localities and under similar physical site conditions, it is believed that the retardation of growth is due entirely to the presence of bear clover. How serious this is can only be realized by the comparison shown in Table 4:

TABLE 4.—*Height Growth of Young Trees. Stanislaus National Forest.* (Height in inches.)

Bear clover years	Sugar pine		Yellow pine		Incense cedar		White fir	
	Present	Absent	Present	Absent	Present	Absent	Present	Absent
5	3	7	3	6	3	5	3	5
10	8	22	8	20	9	13	6	10
15	13	43	12	42	14	24	10	17
20	20	89	19	93	20	36	14	27
25	29	..	28	..	28	49	20	39
30	40	..	38	..	36	65	27	53
Years to 54 inches	36	17	38	18	41	27	44	31

These data show the great spread in the rate of growth in the early ages due to the presence of bear clover. How tremendous this is is brought out more clearly on a per cent basis. Thus the presence of bear clover is responsible for an increase in the time required to reach 54 inches—the point at which diameter measurements of trees are usually made—in the sugar and yellow pines of 112 per cent over that in the open, and 52 per cent for incense cedar and 42 per cent for white fir. At the stump height, which is usually about 18 inches, the increase amounts to 100 per cent for sugar pine, 114 per cent for yellow pine, 46 per cent for cedar and 44 per cent for white fir.

Such a difference in the rate of growth in the early ages is of great importance in connection with the management of the stands. At the present time, the rotation for the pine and fir forests is generally considered to be somewhere around 75 years. Most of the Sierra forests

under management are being cut so as to save advance reproduction to furnish the second cut with thrifty seed left as an insurance against fire. With such a short duration, anything which retards the growth rate of the reproduction left on the ground is of serious moment and becomes all the more important where areas are burned over after logging. The studies thus far conducted do not yet show to what extent the seedlings in the forest and in competition with the bear clover will recover after the release from the older stand as contrasted with those competing with the bear clover, but it is believed that there will be a decided difference in favor of those trees on areas free from the plant, though probably this difference is not as striking as that already depicted.

IS DOUGLAS FIR REPLACING WESTERN YELLOW PINE IN CENTRAL IDAHO?

By C. F. Korstian and F. S. Baker

Forest Examiners, U. S. Forest Service

The silvicultural management of forests on a sustained yield basis dictates a satisfactory restocking of all cut-over areas and the maintenance of forest lands in a potentially productive condition. The securing of adequate natural reproduction of the most desirable species in the shortest possible time is, therefore, of the greatest concern in the rational silvicultural management of any forest. Wherefore, since western yellow pine lumber is considered to be of a quality superior to that of Douglas fir, considerable apprehension has been felt by foresters because of the apparent replacement of the pine by Douglas fir in central Idaho. In 1913, Sparhawk [1] made a study of Douglas fir reproduction on the Payette National Forest with special reference to its apparent encroachment upon western yellow pine stands. Three main topographic situations are covered by the Carpentier and Big Pine Creek plots: (1) southern aspects bearing pure stands of western yellow pine, (2) basins and coves supporting both western yellow pine and Douglas fir but with the former somewhat in the ascendency, (3) northern aspects having both species in mixture but with Douglas fir predominating. This series of plots was examined in June, 1918, August, 1919, and June, 1920. Since the results have a bearing on the problem of the apparent encroachment of Douglas fir upon western yellow pine stands, both series will be discussed together.

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[1] Sparhawk, W. N. Natural Reproduction of Douglas Fir in Idaho, Season of 1913. Ms. report, 36 pp. 1913. In this study, eighteen plots 10 feet square in Deadwood Basin and two on Silver Creek were laid out and permanently staked. On each of these the reproduction was mapped and each seedling given a number. Five years later, in June, 1918, the plots were re-examined, heights of all seedlings and saplings being measured. The next examination was in June, 1920. This series of plots was augmented in 1914 by the addition of thirty 10 by 50-foot reproduction plots laid out within a group of permanent sample plots which Sparhawk was establishing on the Carpentier and Big Pine Creek watersheds also on the Payette National Forest. All of the forty-eight plots were in virgin stands.

COMPOSITION OF REPRODUCTION

As a result of his study, Sparhawk [2] concluded that the invasion of Douglas fir was not actual, but only apparent, as he found that the composition of the stand had been about as it now is for the past 200 years or more, and no profound change is at present threatened. In recent reproduction the Douglas fir appeared to be losing to lodgepole pine, while western yellow pine was about holding its own or gaining on Silver Creek.

On the Deadwood Basin plots, five species occur in the following relative abundance: Douglas fir, western yellow pine, lodgepole pine, alpine fir, and Engelmann spruce. At the time of the 1913 examination this relation was conditioned partly by recent seed crops, one-year old seedlings making up a high percentage of the total number. There was practically no reproduction of western yellow pine in 1912, excellent in 1913, a moderate amount of Douglas fir both years, and a large amount of lodgepole pine in 1913 following a rather moderate quantity in 1912. Since that time there is no evidence that good seed crops have occurred except in the case of alpine fir, which seems to have borne some seed in 1917 and 1919. In 1913 there was a very large proportion of one-year old seedlings, the class in which mortality is very high, and the changes in the composition of the reproduction on the plots have been due primarily to differences in the death rate of the different species in the 1913 seedling crop and the proportion of 1913 seedlings in the total stand. In the 1913 examination the respective percentages of 1913 seedlings of each species were as follows: Douglas fir 9.8; western yellow pine 20.7; and lodgepole pine 52.2, so that given equal mortality rates in this class for each species the Douglas firs would show lower mortality simply because there were fewer of them in the youngest class where death is very great, while for the same reason lodgepole pine ran the highest. In the 1913 seedling class 86 per cent of the Douglas fir was dead by 1920, 92 per cent of the western yellow pine and 90 per cent of the lodgepole pine. The composition of the reproduction of all ages in Deadwood Basin in 1913, 1918 and 1920 is shown in Table 1; that on the Big Pine Creek watershed in Table 2.

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[2] Loc. cit.

TABLE 1.—*Composition of Reproduction by Species and Total Mortality on Silver Creek and Deadwood Basin Plots.*[3]

Year	Western yellow pine	Douglas fir	Lodgepole pine	Alpine fir	Death all species 1913-1920
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Deadwood Basin—					
1913	21.9	63.2	9.2	5.7	....
1918	21.1	63.4	5.3	10.2	....
1920	20.5	65.7	5.0	8.8	38.8
Silver Creek—					
1913	37.6	62.4	....	....	....
1920	77.0	23.0	....	....	73.4

[3] Engelmann spruce omitted as unessential. One small seedling was found in 1913, 1918 and 1920.

TABLE 2.—*Composition of Reproduction by Species and Total Mortality on the Big Pine Creek Plots by Sites.*

	Western yellow pine		Douglas fir		Death all species 1914-1920
	1914	1920	1914	1920	
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Southern aspect	93.4	91.2	6.6	8.8	49.3
Basin	57.9	61.4	42.1	38.6	46.8
Northern aspect	18.4	15.2	81.6	84.8	29.8

Viewing these data in the light of the above discussion, it will be seen that conditions are remaining essentially unchanged as between western yellow pine and Douglas fir. The lodgepole pine increase noted by Sparhawk appears to have been temporary, due to good seed years, and is now on the wane. The behavior of alpine fir is not alarming. In 1913 there were no new seedlings, so that this species was exempt from infant mortality reductions, while it happened that light reproduction occurred in 1918 and 1920. Certain fluctuations with seed years and variations in climatic conditions must be expected, but too much emphasis must not be placed on them either way.

The Silver Creek, Carpentier Creek, and Big Pine Creek plots are at a lower elevation than those in Deadwood Basin and more typical of the western yellow pine type. Although certain of the Big Pine Creek plots are considered as being in the western yellow pine type, they are

quite typical of northern aspects where Douglas fir begins to gain the ascendency over western yellow pine when in direct competition with it. In the Deadwood Basin, Plot 72 is on one of the warmest, driest slopes, but still Douglas fir shows up the best. Plot 70 is in an area of very dense reproduction on a shaded northern aspect, where all species appear to be about equally suppressed and injured, except the tolerant alpine fir. A leaf disease, *Phacidium infestans,* has caused much of the loss in the fairly tolerant Douglas fir and promises to continue as a cause of mortality on the plots. This fungus is known to be very destructive to firs in northern Europe and has been repeatedly found by Weir [4] in northern Idaho and western Montana, where it is especially destructive on branches covered by snow. On the Big Pine Creek plots, another leaf fungus, *Hypoderma deformans* [5] was frequently found to be the cause of fairly heavy losses of western yellow pine seedlings and saplings, and ranks along with suppression as a cause of mortality in this species on northern aspects and in basins, especially where the cover is rather dense. Besides defoliating the young trees, it also causes brooms on the branches of older trees.

By far the greatest mortality was found in seedlings less than a year old. Very few over 6 inches high are killed in any one year. The most serious causes of death, aside from the two just mentioned, are in the order of their importance: drought, browsing and trampling by grazing animals, especially sheep, girdling by rodents, winter-killing, including excessively low temperatures, frost injury, and rodents or birds which bite off the newly germinated seedlings. Seedlings and saplings 15 to 20 years old were occasionally found girdled by rodents. Balanced against this is the fact that rodents render considerable aid in disseminating and burying the seed, thereby promoting favorable conditions for satisfactory germination. On one 20-acre plot a large proportion of the yellow pine seedlings were growing in groups, some with as many as 20 seedlings in a cluster, but averaging about 5, and obviously originating in rodent hoards. The late spring frost of 1919 [6] constituted another cause of considerable damage in central Idaho.

[4] Weir, James R. *Phacidium Infestans* on Western Conifers. Phytopathology, 6: 413-414, 1916.

[5] Weir, James R. *Hypoderma Deformans,* an Undescribed Needle Fungus of Western Yellow Pine. Jour. Agri. Research, 6: 277-288, 1916.

[6] Korstian, Clarence F. Effect of a Late Spring Frost Upon Forest Vegetation in Utah. Ecology, 2: 47-52, 1921.

Great changes in certain plots are due more to the high percentage of 1913 trees in the original mixture than to well defined differential mortality due to unfavorable site factors. On one plot (67) the lodgepole pine shade is fairly dense and the loss of all western yellow pine and the heavy loss of lodgepole pine would perhaps seem to be due to well defined site factors. This may be true, but since all of the western yellow pine and 75 per cent of the lodgepole pine were 1913 trees, while only 9 per cent of the Douglas firs were of that year, the proof is inconclusive.

On the whole, therefore, it appears that the local distribution of the seed crop of 1912 and the conditions of germination in 1913, influencing the proportion of 1913 seedlings on the plots, has been the main factor in changing the composition of the seedling stand from 1913 to 1920. Careful examination of the records of the individual plots leads to one conclusion, which is, however, almost axiomatic. The various species show the least loss from 1912 to 1920 on the plots where they make up the greatest percentage of the stand—which means that each species is now coming in most successfully on sites where it has come in most successfully in the past, which, again, is equivalent to saying that Douglas fir does best on potential Douglas fir sites, and western yellow pine best on western yellow pine sites.

DISTRIBUTION OF SIZE CLASSES

The distribution of size classes and the change from year to year is a function of height growth and selective mortality in the several classes.

There was naturally a heavy decrease in the 0-0.5 foot size class, as this is where the infant mortality in the 1913 seedling class fell. The 0.6-1.0 foot class showed a slight decline in the case of western yellow pine and Douglas fir, due to losses both by death and by trees passing into the next higher size class with no compensating increase from the 0-0.5 class; while in the case of lodgepole pine accessions from below over-balanced the losses and caused a slight numerical increase. In larger size classes mortality was low, but owing to slow growth few trees passed from one class to another even in 7 years, so there was accordingly little change. What little there was resulted in a general increase in numbers over the whole 7-year period.

GROWTH ON DIFFERENT SITES

The comparative heights of reproduction in Deadwood Basin and on the three different aspects on Big Pine Creek on the basis of age are shown in Table 3. Differential growth rates are evident both for different species on the same site and the same species on different sites. Of most interest, however, is the more rapid growth of western yellow pine as compared with Douglas fir on the same site which favors the former species. Table 4 gives the current height growth of western yellow pine and Douglas fir on the Deadwood Basin and Big Pine Creek plots by size classes. When size is substituted for age, it appears that the decrease in growth rate during the last seven years is considerably less marked. That is, a tree a foot tall now is growing at very nearly the same rate as a tree of this height grew in earlier years. This shows forcibly that, for any given age, the small trees that are below the normal size for that age are growing disproportionately slowly, although a certain retardation with increased age is present in every size class. The mechanics of this is more evident in even-aged stands. Here all the trees when young are about of a size, but this accordance disappears with age, and a stand of irregular sizes is speedily developed.

TABLE 3.—*Comparative Heights of Reproduction in Deadwood Basin and on Big Pine Creek.*

Age	Total height (curved)									
	Deadwood Basin				Big Pine Creek					
					Southern aspect		Basin		Northern aspect	
	Western yellow pine	Douglas fir	Lodge pole pine	Alpine fir	Western yellow pine	Douglas fir	Western yellow pine	Douglas fir	Western yellow pine	Douglas fir
Years	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
5	0.27	0.17	0.20	0 13	0.40	0.20	0.32	0.20	0.25	0.28
10	0.63	0.39	0.58	0.25	1.05	0.45	0.80	0.50	0.65	0.58
15	1.17	0.84	1.25	0.46	4.16	0.75	1.68	0.90	1.42	1.10
20	1.91	1.47	2.38	0.88	9.58	....	3.00	1.60	2.70	2.00
25	2.95	2.10	4.00	1.63	....	....	5.10	2.80	4.60	3.00
30	4.15	2.80	6.15	2.75	....	....	8.42	4.10	7.55	5.00
35	5.65	3.65	9.95	....	....	....	12.20	....	11.20	8.60
40	8.15	4.65	15.70	....	....	....	....	....	15.10	12.60

TABLE 4.—*Periodic Annual Height Growth of Reproduction by Size Classes.*

Height class	Periodic annual height growth						
	Deadwood Basin		Big Pine Creek				
			Southern aspect	Basin		Northern aspect	
	Western yellow pine [1]	Douglas fir [1]	Western yellow pine [2]	Western yellow pine [2]	Douglas fir [2]	Western yellow pine [3]	Douglas fir [3]
Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
0 — 0.5	0.03	0.03	0.04	0.02	0.02	0.02	0.03
0.6— 1.0	0.06	.05	0.13	0.04	.04	0.04	.05
1.1— 1.5	.09	.08	0.23	.06	.06	0.06	.06
1.6— 2.0	.11	.11	0.35	.09	.08	0.08	.07
2.1— 2.5	.14	.13	0.48	.12	.09	0.09	.09
2.6— 3.0	.16	.16	0.62	.16	.11	0.10	.10
3.1— 3.5	.19	.19	....	.19	.13	0.11	.11
3.6— 4.0	....	....	....	.23	.16	0.12	.12
4.1— 4.5	....	....	....	.27	.22	0.13	.13
4.6— 5.5	....	....	....	.35	.32	0.15	.14
5.6— 6.5	....	....	....	.50	....	0.17	.15
6.6— 7.5	....	....	....	....	....	0.21	.16
7.6— 8.5	....	....	....	....	....	0.25	.19
8.6— 9.5	....	....	....	....	....	0.29	.22
9.6—10.5	....	....	....	....	....	0.34	.26
10.6—11.5	....	....	....	....	....	0.40	.31
11.6—12.5	....	....	....	....	....	0.54	.37
12.6—13.5	....	....	....	....	....	....	.45
13.6—14.5	....	....	....	....	....	....	.54
14.6—15.5	....	....	....	....	....	....	.65

[1] Based on 7-year period. [2] Based on 6-year period. [3] Based on 5-year period.

It will be noted that, considered from this angle, the height increment of Douglas fir and western yellow pine is practically identical, while on an age basis the growth of the pine was notably greater. This appears anomalous at first glance, but it must be remembered that Tables 3 and 4 are obtained from different basic data. Table 3 includes the growth of western yellow pine and Douglas fir seedlings from the time they started to the present. The height at five years is made up from measurements taken of all the trees on the plot ranging from five to forty years of age and is strongly affected by the rate of growth shown in the older saplings. The older trees started when the plots were more open than they are now and these trees were practically the only ones on the ground. During the time that there was no competition of seedlings on these plots, the western yellow pine grew very much more

rapidly under the excellent light conditions than did the Douglas fir and has left its impression on the figures given in Table 3. Many of the plots are now congested with reproduction; in fact, most of them present this appearance. Under such conditions of crowding and shade the growth of western yellow pine has become considerably reduced, so that for trees of equal size it is about the same as for Douglas fir. However, these trees of the same size which at present are growing at the same rate, have not always done so; the western yellow pine being considerably younger than the Douglas fir on account of the fact that it had an opportunity to grow much more rapidly.

To determine its effect on the rate of height growth and the possibility that the replacement of western yellow pine by Douglas fir might not have been checked temporarily by a dry cycle falling within the seven-year period during which the plots were under observation, the climatic factor was also investigated. While it has been shown [7] that in this region the amount of precipitation during April and May is important in determining the amount of height growth, the possibility of a decisive climatic change in the last few decades resulting in a drier present day climate may be dismissed with the statement that the records of the U. S. Weather Bureau at Boise covering the last 40 years indicate nothing of the kind. The observed diminution in growth rate, therefore, cannot be thus explained.

The effect is much more easily explained as being due to mutual crowding. The young trees of today are growing under much more difficult circumstances than those which came in twenty years ago, when the plots were practically open. Then, too, it is commonly held that light requirements increase with age. If so, the trees which are shaded by a canopy of greater or less density on practically every plot should be showing a greater degree of suppression as age increases.

MORTALITY AND AGE

The death in the one-year old class has been mentioned before as the prime factor in determining composition changes. Death in the upper age classes is of interest also, and for western yellow pine and Douglas fir is given in Table 5. The mortality of Douglas fir continues with age at a higher rate than western yellow pine on the same site.

[7] Korstian, Clarence F. Relation of Precipitation to Height Growth of Forest Trees Saplings. Trans. Utah Acad. of Sciences, 2:259-266, 1921.

This data is very significant in that it indicates that Douglas fir is incapable of replacing western yellow pine on many of the sites under observation.

It must be remembered that this is for the most part advance reproduction in virgin stands, which on many of the plots is at present crowded. These figures show that about 5 to 6 per cent of the one-year old seedlings succeed in reaching 30 years of age.

TABLE 5.—*Relation of Age to Mortality of Advance Reproduction.*

Between ages of—	Mortality (curved)						
	Deadwood Basin		Big Pine Creek				
			Southern aspect	Basin		Northern aspect	
	Western yellow pine [1]	Douglas fir [1]	Western yellow pine [2]	Western yellow pine [2]	Douglas fir [2]	Western yellow pine [3]	Douglas fir [3]
Years	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1—8	92	88	95	85	96	95	90
2—9	78	79	89	74	90	86	84
3—10	69	71	55	65	85	77	77
4—11	62	65	35	56	78	70	70
5—12	55	59	25	50	74	63	65
10—17	32	38	8	26	50	42	44
15—22	17	24	2	11	32	29	29
20—27	8	14	—	2	18	20	18
25—32	2	7	—	—	8	12	10
30—37	—	2	—	—	2	6	4

[1] Based on 7-year period. [2] Based on 6-year period. [3] Based on 5-year period.

PERIODICITY OF REPRODUCTION

Reproduction, particularly in drier situations, is known to occur in cycles, following years with favorable moisture conditions. This is well shown by the Deadwood plots, where there is found for the eighteen plots a slow, fairly even increment of about ten Douglas fir and five western yellow pine seedlings per year—equivalent to 244 Douglas fir and 122 pine per acre per annum. Twice in the last 36 years there have been notable years of reproduction for Douglas fir, one in 1891, the other in 1905. The latter was preceded by a very good year and followed by three above the average, making a combined 5-year period very favorable to Douglas fir. Western yellow pine showed an outstanding year in 1899, with a very good one five years

later. Nineteen hundred and twelve was also better than the average; it was fairly wet, especially June and early July. The good years for the two species do not coincide and it is impossible to correlate either with total rainfall from monthly records at Boise, or with rainfall for the summer months. It seems on the whole that a slow moderate reproduction is normal with exceptional periods of favorability running 5 to 15 years apart. Of course, owing to progressive mortality, a large number of seedlings 25 years old indicate a much larger initial supply of seedlings than an equal number only 2 or 3 years old, since death has been thinning out the older stand for many more years. On the other hand, conditions were not as severe for the young seedlings on these plots 25 years ago as they are now, owing to less crowded conditions, and suppression could not have taken the toll it now exacts.

The whole country used to burn over every few years. The frequency and intensity of forest fires doubtless influence the periodicity of reproduction. Large fires were quite general all over central Idaho in the early eighties, according to evidence shown by fire scars and the young growth.

CONCLUSIONS AND APPLICATIONS

The present composition of the forest will persist, and is not being modified appreciably by new factors introduced by man (chiefly grazing) during the last 30 years. Western yellow pine will follow western yellow pine, Douglas fir, Douglas fir, and mixtures as found today will likely continue.

Inasmuch as these results were secured in virgin stands conditions following cutting will be even more favorable for western yellow pine than Douglas fir in the tension zone. Lodgepole pine may show sudden temporary increases due to local conditions, but will decrease again except after heavy interruptions of the forest canopy, such as are caused by fires.

Height growth of advance reproduction is slow and becomes slower for trees of equal age as the density of stocking increases, presaging an ultimate stagnation in the sapling stages.

These conclusions point to the desirability of taking advantage of young advance reproduction and freeing it by cuttings which can be made, in this region at least, without fear of leading to a permanent increase, in the mixture, of species at present unmerchantable.

NATIONAL FORESTRY IN PENNSYLVANIA[1]

By L. L. Bishop

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Pennsylvania's contribution to National forestry has been monumental. The Federal Forest Service will long bear the stamp of Pennsylvania ability, courage, and integrity. It is with no little satisfaction that the U. S. Forest Service now finds itself possessed of the opportunity of contributing to forestry in Pennsylvania. True, there has long existed the closest and most sympathetic co-operation as to certain lines of endeavor, notably fungus control and fire protection through Weeks law co-operation. It is only, however, with the inauguration of the purchase program on the Allegheny National Forest purchase unit that the Forest Service is able to share and share alike with the State in working out Pennsylvania forestry problems. The Allegheny purchase unit has been assigned the United States Government, and in that unit we accept the responsibility for so handling the area that every acre of land and every resource be put to and kept at the use to which it is best suited, having always clearly in mind the most good to the greatest number in the long run. Within the Allegheny purchase unit the Forest Service proposes to carry out the slogan "Restore Penn's Woods."

Under the provision of the Weeks law passed by Congress in 1911, provision was made for the purchase of forest lands at the headwaters of navigable streams in the eastern United States. In accordance with this law, the National Forest Reservation Commission has authorized the establishment of seventeen purchase units, within which more than two million acres of land have now been acquired. The Allegheny purchase unit in northwestern Pennsylvania, established in October, 1921, is the last of the seventeen. The late date at which this work was undertaken in the State of Pennsylvania is in no way indicative of the importance placed upon the work by those charged with the carrying out of the eastern National forest program. Before Federal work in any State is undertaken, it is necessary that the State, through the proper agencies, invite or at least welcome the National Government.

[1] Paper read before the Pennsylvania Section of the Society of American Foresters, March, 1922.

This in the form of an enabling act. The enabling act as first passed by the Pennsylvania legislature provided that Federal purchases could be made in the State when approved by the State Forest Commission and the State Water Supply Commission, and that such areas as purchased might later be taken over by the State upon payment of the purchase price, plus interest at 2 per cent. It did not seem practicable for the Federal Government to proceed under such a plan, and until the provision for State purchase was removed in 1921, nothing was done looking toward the establishment of National Forests in Pennsylvania. The fact that Pennsylvania had done and was doing more than any other State in the Union toward adequately meeting forestry problems, did not cause the Federal Forest Service to be the less interested in the work within the State. Quite the reverse. I am sure that it was the feeling generally that the State merited all encouragement which could be shown and which would result from the joining of State and Federal forest forces, and further that such a union would be of great mutual benefit. I am quite as sure that the results will more than justify this belief.

Since Federal acquisition work was taken up in Pennsylvania it has been most vigorously prosecuted, as a brief sketch of the history of the work will show. Of the one million acre purchase unit established by the National Forest Reservation Commission, the two State commissions have approved Federal purchase of 412,000 acres. On October 29, after a personal examination of the unit by Associate Forester Sherman and Assistant Forester Kneipp, it was announced that a purchase program would be undertaken. Today more than 50,000 acres of land have been offered for sale within the unit, has been examined, and reports are in the process of preparation. Two examination crews have been in the field almost continuously throughout the winter. In addition, a crew is now engaged in making a comprehensive young growth study. The Forest Service title attorney is on the ground, and it is expected that the surveyor will report within the near future. It seems certain that not less than 85,000 acres of land will have been offered, examined, considered, and passed upon before the close of the current fiscal year. At least $150,000 is available for purchase of lands within the Allegheny unit during this fiscal year. It is confidently expected that not less than 50,000 and perhaps as much as 70,000 acres will be approved for purchase before July next.

For the rest of my allotted time I wish to tell you in some detail about the plan, policy, and expected results of the Allegheny Purchase Unit. I shall be guided in what I have to say by what I have found the people of the State generally are most interested in.

First.—Why did the Federal Government see fit to take up forest land acquisition in this State? The primary reason for the establishment of National Forests in any State in the East is that the Federal Government may discharge its recognized responsibility as to the protection of the head waters of navigable streams. Such streams usually flow through several States and in that the conditions which exist at their sources affect the river throughout its course, and especially its lower reaches, it is at once evident that the matter is a National and not a State question. The Allegheny River in western Pennsylvania is an especially good example of this.

The next question is naturally—now that the Federal Government proposes to establish a National Forest at the head waters of the Allegheny River—how will the desired end be accomplished? Will anyone's and everyones' land be acquired by condemnation if necessary? Land is not to be acquired by arbitrary condemnation. We are purchasing land on the open market and subject to any competition that may be present. It is expected that a good many years will be required to satisfactorily round out the present purchase unit.

Another point as to the purchase policy—lands are being considered subject to the reservation of gas, oil and mineral right. Such rights often constitute a large part of the value which the owner places upon his property. The Government is not in the mining of gas and oil business, and in that only the surface of a piece of property is required for the production of timber crops—the purchase of the surface is all that is necessary.

Upon taking up the National Forest work in northwestern Pennsylvania we at once recognized that the gas and oil industry was the dominant industry of the region and knew full well that if our program was to succeed it would have to be guided by a policy that would encourage the gas and oil business. Nor is it the desire of the National for the production of timber crops, the purchase of the surface is all prise, but rather to encourage and benefit all.

Well then, once the land is acquired what will be the results to this State, to the local community and the local people? It so happens that

it is most feasible to satisfactorily protect the water sheds of navigable stream and at one and the same time produce repeated forest crops. As to timber production the Allegheny National Forest will function exactly as do your State Forests, nor is this similarity confined to timber production. All the way through, the purpose, use, and results, will be quite the same as for your State Forests. Perhaps the most important result will be that the local wood using industries will be provided a continuous supply of raw material. It will be the policy to grow the kind and quantity of material needed locally in so far as will be consistent with the best management of the property.

The Forest will, as do yours, serve as public recreational grounds. I expect the Allegheny Forest to become one of the most important of our National play places. Its use in this direction will be especially encouraged. Already we have received applications for summer home site permits, and inquiries as to camping grounds. Completion of road projects already conceived will make the region readily accessible to more than a million people. The Forest Service will establish public camping grounds, rest houses, and set aside areas for use by those who wish to build permanent camps.

Hunting and fishing is an authorized use of a National Forest. The Allegheny National Forest will come to be a great hunting and fishing ground in which the public will be just as welcome as is not the case in your State Game Preserves. I have been pleased to note the interest which the people in this State take in sports which take them so much into the forests. Such an interest makes for better public health and for the betterment of forest conditions.

While it is not the wish of the Forest Service to purchase farm lands, in acquiring large boundaries it often so happens that the Government comes into possession of certain areas of agricultural land. Provision is made for the leasing of all lands that are suitable for farm purposes and it is possible that it would be better for some farmers to lease land under special-use permits than to own the land. The Forest Service takes an interest in all farming done on National Forest land and is often able to suggest improved agriculture methods which greatly benefit the farmer.

In the development of a National Forest the ideal toward which the Forest Service works is the establishment of such permanent rural communities as the region will reasonably support. Such communities

will be dependent in part upon agricultural products and partly upon woods work. Such a plan contemplates not only the full use of all farm lands, but in addition a complete and satisfactory system of roads. It is only through the influence of roads that the standard of living can be such as to conform to Forest Service standards. Roads mean educational, industrial and social advantages. It is the policy of the Forest Service to co-operate just as fully as possible in the construction and maintenance of roads, nor is its interest confined to main thoroughfares. The back country roads are quite as important. The recent Federal Aid Road Bill carried an appropriation of $75,000,000 Federal aid on State roads. In the same measure was included a $15,000,000 item for National Forest roads. By comparing of the area outside the forests upon which the 75 million is to be applied, with the National Forest area it will be seen that the 15 million item is much the more ambitious.

In closing let me say that a National Forest could not long exist in a State except it proved a benefit to the State in general and to the local settlers and industries in particular. Public opinion is the acid test. The Allegheny National Forest will, I am confident, measure up to its opportunities and abundantly justify its existence.

FORESTRY IN GERMANY SINCE 1914

By C. A. Schenck

Former Director Biltmore Forest School

An American traversing Germany in 1914 and again in 1922 would not detect, indeed, any difference whatsoever between forestry in Germany then and forestry in Germany now. None of the German assets is less affected by the horrors of the last eight years than the German woods. Farming suffered badly from neglect while the men were in the army, further from lack of live stock, and notably from lack of fertilizers, without which crop-production is, with us, impossible. The railroads are run down and yield, for various reasons, a deficit in lieu of a revenue. The merchant marine is almost gone, under the Versailles pact. The colonies are lost. The postash industry has ceased to be a German monopoly; so have the dye-works. The industries yield a wonderfully high rate of revenue expressed in paper marks, and a miserable revenue expressed in gold. A 60 per cent dividend in paper is less than a 1 per cent dividend in gold.

Yet the woods stand intact. They have been saved, it seems, by a very miracle, after yielding, during the war, timber for trenches and guns and airplanes; fuel when there was no coal; cotton substitutes for nitro-cellulose, for hygienic bandages, for sacking and packing; stable litter when there was no straw; turpentine and fats (beechnuts) when the foreign importation had ceased; and, indeed, leaf food for horses and for cattle, though on an insufficient scale.

Indeed, while some 10 million men were wearing the uniform, there were not hands enough left to cut as much as the regular annual "sustained yield."

Forest property has proven to be the best, the safest, the most remunerative investment.

Today, though there are no building activities, the demand for timber is enormous; so is the call for pulpwood, for fuel wood, and even for charcoal. Oak tanbark, which was a drug on the market in 1914, fetches a price which, even translated into gold marks, is satisfactory.

Why all that? Prior to the war, one-third of the timber used in Germany was imported. Today, Germany is unable to pay for any

importations. Prior to the war, there was an abundance of coal. Today, with the coal of the Sarre region and of parts of Silesia lost, with 2 million tons of coal due, monthly under the Versailles pact, to the victors, there is a general lack of coal, so much so, that many industries are running on wood instead of running on coal.

Nevertheless, in the State forests, in the communal forests, and in the entailed forests of Germany, the annual cut has not been increased or else has been increased so little as to keep the demand for woodgoods far above the supply of woodgoods.

Helas! If the forest owners, controlling the market by concerted action and by open combinations in restraint of trade, were confronted by a Sherman antitrust law, all of them would have to go to Sing Sing.

What is a "sustained yield," indeed, unless it be, when generally adopted, a combination in restraint of trade?

Verily, I say unto you, there will not be any American forestry unless the Sherman antitrust law be altered in favor of sane forest conservatism. *Unlimited competition,* in the face of *limited* supplies of timber, spells economic suicide.

True, a sustained yield is not *generally* adopted in Germany. The owners of small woodlots do not stick to it; and these owners, after a period of noncutting during the war, are overcutting their holdings today, tempted by high prices, and forced to make money by high taxes on all and on everything.

FOREST POLICY

In forestry instruction, the tendency is toward concentration of effort. Germany is now too poor to maintain, on a high level, its institutes of forest learning. Thus it happened, e. g., that the universities of Tübingen and the Karlsrhue-Tech have combined their forest schools in the University of Freiburg; that the old Prussian forest school at Muenden has been abandoned; while the time-honored institute at Tharandt in Saxony is apt to become attached to either the University of Leipzig or else the Dresden-Tech. All of the institutes are short of funds. And forest research work is badly handicapped.

Under the new democratic constitution, the family entails were to be dissolved. Yet it was found that a dissolution of the forest-entails was or would be a bad blow on forest conservation Thus nothing has been done, so far. Organizations similar to joint stock companies may be the result.

In the various State diets, to still the urgent call for new farming lands and for their products (over one-third of Germany's food must be imported), the demand has been made to convert forest land, wheresoever it stocks on tillable soil, into farm land. In this connection, little progress has been made. On the one hand, there is the resistance to such demands of all foresters in a united front; on the other hand, by such inroads, the normal gradation of age classes in the woods, obtained by decades of unswerving effort, would be thrown overboard. And, in addition, the forests in the proximity of the cities, where the call for new land is particularly pressing, are used to such an extent as parks for the whole people (not merely for the owners of automobiles) that, in every given case of proposed deforestation, the "noes" have it, and not the "yesses." Also, some conversions of woodland into farmland, undertaken on a large scale by the authority of the State, have proven to be utter failures, financially.

Nevertheless, it can be stated that there is as much deforestation now, in order to gain farms and gardens, as there was afforestation prior to the war, in order to convert unremunerative farmland into forest. Both kinds of mutations were and are insignificant, expressed in percentages of the total area of woodlands.

So as to check indiscriminate cutting of fuel wood on farm-woodlots, some States have adopted the rule of *distributing* all the wood cut, per capita of the population, at fixed prices, and forbidding any free sale of fuelwood. Other States, so as to prevent the fuelwood prices from going skyward, have forbidden any sale of fuelwood at public auction. Such measures of coercion, temporary in their effects at best, are being gradually abandoned, or else have already been dis-discontinued.

Under the Versailles treaty large quantities of prime timber (also ties and poles) must be furnished to France, Italy, and Belgium. Little has been done. There are several reasons. The prices stipulated are so low that the central government cannot obtain anything at them; and the German government as such does not own one acre of woodlands in *National* forests, all government forests being *State* forests. Further, the French and the Belgian timber merchants do not want to lose their trade. Thus it happens that all the mills in Western Germany are busy with French and Belgian private orders; while the official representatives of the various sides cannot—good will or bad will—obtain the results desired.

FOREST UTILIZATION

In the methods of logging and of lumbering there is nothing new to be related. The high prices of lumber have induced many a novice to engage in milling; invariably with dastardly results for every one, except for the makers of sawmill machinery. In sawmill machinery there is no innovation. The vertical gangsaw, with blades of 26 or 28 gauge, and the horizontal straight saw (cutting on either movement of the saw), with its wonderfully smooth and fine kerf, are ruling supreme, hereafter as heretofore. To many a mill, in the softwood region, a small groundwood pulp plant has been attached, to consume slabs and refuse with satisfactory results, where there is waterpower. The sawmills are running at the double quick, in three shifts of 8 hours, spurred by urgent orders. I need not tell the readers of this journal that, in Germany, the owner of a forest is but in rare cases also the owner of a sawmill. Logs, pulpwood, fuelwood, and tanbark are sold at public auction to the highest bidder. If a minimum price, pre-arranged among the owners' associations (States, communities, church-funds, entail), fails to be obtained, the auction is not approved by the owner, under the very conditions read prior to bidding, and a new auction is ordered. Lo, how the good public in the good U. S. A. would howl if it were exposed to such cut-throat methods! Yet, when the public itself, as owner of the main body of the woodlands, is the beneficiary of high prices, not much harm is being done.

In forest transportation the autotruck has made considerable advance. All transportation, from the woods to the railroad, goes, of course, over permanent macadam forest roads in which lies, in my opinion, the very secret of all forest conservation in Central Europe. Transfer the macadams spanning and riddling the German Black Forest bodily to the Adirondacks, and no owner would continue, in the Adirondacks, any indiscriminate cutting. Conservative lumbering would be, at once, more remunerative than destructive lumbering, particularly so, if the main macadams are maintained at public expense. Permanent forestry is, *de facto*, a problem of permanent arteries of transportation.

Tanbark and chestnut wood and oak wood are used, in 1922, on a scale absolutely new in the German tanneries.. They cannot pay for quebracho, for myrobalans, and for catechu; the home-grown stuff *must* answer.

I have referred to bandages of all sorts made, today and since the blockade, of wood cellulose instead of cotton. Every drug store is offering them. I might also mention that real progress has been made, in the use of wood by the viscose process, in the manufacture of spinnable and weavable threads. Artificial silk has, of course, come to stay, its qualities having been wonderfully improved by the United "Glanzstoff fabriken" at Elberfeld. The German dynamite trust, forced to find a peaceful use for its former bellicose energies, has placed on the market, more recently, a woodwool styled "Vistra-wool" which is said to be a fair substitute for cotton. Is King Cotton going to be deposed by King Wood?

SILVICULTURE

Silvicultural fashions have been changing, in Germany, during the last 50 years almost as rapidly as have ladies' fashions on Broadway. None came to stay. Today, the newest fad is the "Dauerwald" or "Timber-perpetuation," a system or a mode which strictly avoids clear-cutting, even on minute units of area, which discards planting of seedlings or of seeds, and allows nature to do all the work. Another novelty is the regeneration from self-sown seeds coincident to cuts made wedge-shape, successively. And there may be other panaceas to solve all problems of regeneration, at one stroke.

In thinnings, the "par le haut" begins to prevail over the variety "par le bas."

The wages have risen so tremendously that plantations of pine costing, in 1914, 150 gold marks per hectare, equal to $15 per acre, entail an outlay today of 5,000 paper marks per hectare, equal to some $17 per acre! A tremendous difference, indeed! Yet tremendous only from the German standpoint. As a consequence, fewer seedlings are being used per acre, and reinforcing, that old bugbear, is being intensified.

Among the American species planted in Germany, red oak and white pine, the latter in spite of the ravages of the blister rust, continue to lead. There is also a heavy demand for Douglas fir, sawlogs of which are beginning to be offered on the market, from German-grown stock.

To judge from the American literature, the blister rust is not so bad with us as it is in the U. S. A. There is no wild currant in Germany! One of my friends tries to raise a rustless strain or

variety of white pine; another claims that his natural seed regenerations of *strobus* are immune while his plantations are being handicapped.

FOREST FINANCE

Forest finance as a branch of science is dead; the war has killed it. Poor Max Pressler, poor Gustav Heyer, and poor Fred Judeich have all lived in vain. All those finely-spun calculations at compound interest by which the age of maturity, the proper level of the timber investment, the value of immature woodlots, and what not, were to be determined, have proven to be futile. One fact is made plain: In the long run of events the most conservative variety of forestry has proven to be the most remunerative variety of forestry. And Saxony, once the admired leader in forest finance, with its emphasis laid on spruce as the main money-producer, on short rotations, on rapid planting after clean sweeps, Saxony has become the laughing stock of the other States of the German union.

CONCLUSIONS

Germany has become a world-beggar; it has ceased to feel the shame of begging; every American knows it. And, possibly, many an American is or has been imposed upon.

Nevertheless, I close my message with two requests:

Firstly, I want all those forestry institutions in the U. S. A. who see in a German forester a comrade in search of truth and not a Hun in search of pillage, to send their publications, which we are unable to buy, to our German institutes of forestry learning free of charge.

Secondly, I want those American foresters and those American lumbermen who will visit the European continent this summer to look me up in Darmstadt, Heidelberger Strasse 16. I feel so lonely.

SEASONAL DISTRIBUTION OF RAINFALL AS RELATED TO FOREST FIRES IN ARIZONA AND NEW MEXICO[1]

By G. A. Pearson

Silviculturist, Fort Valley Forest Experiment Station

Arizona and New Mexico are very similar climatically, yet the weather records of the two States show periodic differences in precipitation which are of considerable importance in the control of forest fires. These differences are independent of the variations in total rainfall associated with altitudinal changes. New Mexico has rather dry winters, with increasing precipitation in the spring and summer, culminating in the rainy season of July and August. The autumn months are moderately dry. Arizona has heavy winter precipitation, but an extremely dry foresummer which reaches its maximum intensity in June or early July. As in New Mexico, July and August bring abundant rains, while the autumn months are relatively dry. These two sets of conditions do not conform absolutely to the State lines, but nearly so. From the Pacific coast eastward the winter precipitation decreases, whereas that of the spring and foresummer increases. At Los Angeles, 78 per cent of the annual precipitation falls between December 1 and April 1, while less than 4 per cent falls in May and June, and only 0.2 per cent in July and August. At Prescott, Arizona, the corresponding per cent figures are 39, 4, and 34; at Fort Bayard, New Mexico, 22, 7, and 42; and at Fort Stanton, New Mexico, 17, 14, and 40. In a strip extending about 50 miles on either side of the Arizona-New Mexico line, conditions are intermediate, in some years approaching those farther east and in other years approaching those farther west.

Figure 1 illustrates the two extremes and the intermediate type of distribution occurring within Arizona and New Mexico. All the records are from Weather Bureau stations over 40 years old. Although

[1] Presented before the third annual meeting of the Southwestern Division of the American Association for the Advancement of Science, Santa Fe, N. M., Sept. 6-9, 1922.

the total annual precipitation at these stations is somewhat below that prevailing in the forests, the distribution is typical. Precipitation varies greatly with altitude; but within a given meterorological region, seasonal distribution is the same regardless of the total amount. Thus, if we plot the average monthly precipitation for Phoenix, Arizona, with an altitude of 1,000 feet and an annual precipitation of 8 inches, we get a graph which is almost identical in form with that of Flagstaff, situated at 7,000 feet and receiving 23 inches of precipitation.

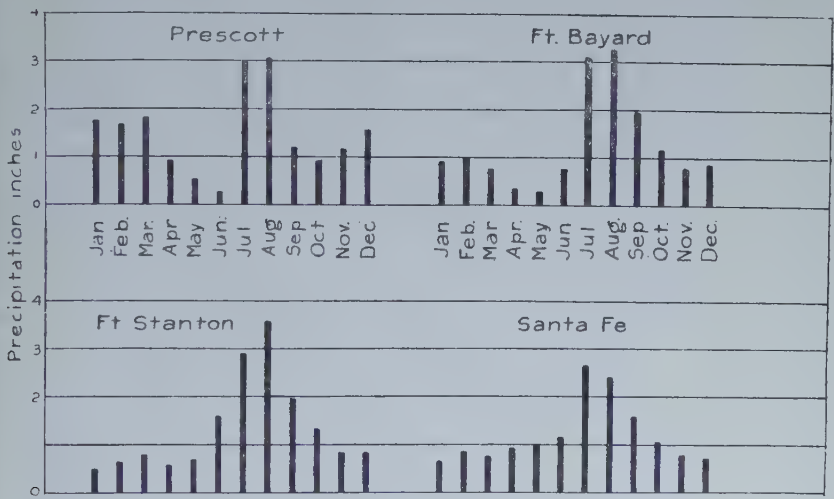

Fig. 1.—Monthly precipitation at representative stations in Arizona and New Merico. From Prescött, Arizona, eastward, there is a steady decrease in winter precipitation, accompanied by an increase during June. Northern New Mexico also receives a considerable amount of rain in May.

May and June constitute the main fire season in Arizona and New Mexico. In certain localities and in abnormal years it may begin earlier than May 1, or may extend well into July. Decidedly the most dangerous condition exists when little or no rain falls between April 1 and July 15. Sometimes, copious June showers bring relief just as the situation is becoming critical. An early fire season is most to be feared in southern New Mexico, because of light snows. The protracted fire season due to intense drought in May, June, and early July is most common in Arizona. An early termination of the fire season by May and June rains is the rule in most of New Mexico, and the exception in Arizona.

How much rain is required to eliminate fire danger depends on a number of circumstances, such as distribution of showers, character of succeeding weather, topography, and the amount and character of inflammable material. A slow, prolonged rain, or a succession of good showers over a period of several days is most effective. Rains of the latter type are most prevalent in this region. If the aggregate downpour amounts to as much as one-half inch, it will ordinarily alleviate the fire situation for about two weeks. With an inch of rain per month, well distributed, through May and June, the control of fires should not be difficult, and if it amounts to two inches per month the danger is practically eliminated.

Records extending from 1913 to 1921 at five stations in the yellow pine forests of northern New Mexico show an average precipitation of 1.57 inches in May and 2.20 inches in June. Four stations in northern Arizona, situated in the same type of forest and receiving about the same aggregate precipitation, average only 0.81 inch in May and 0.38 inch in June. In eight out of the thirteen years covered by these records, the New Mexico stations received over 1 inch per month in both May and June, while at the Arizona stations the 1-inch mark was exceeded only four times in May and twice in June. The yellow pine forest of southeastern New Mexico is represented during the above period by only one station, Cloudcroft. Cloudcroft is above the true yellow pine type, but receives about the same annual precipitation as several of the yellow pine stations in other localities. At Cloudcroft, the average precipitation from 1909 to 1921 is 0.49 inch in May and 1.95 inches in June. Three times in May and ten times in June, the monthly rainfall exceeded 1 inch. The transition zone, about 50 miles on either side of the boundary line between the two States, is not adequately represented by weather records comparable with those cited above. Incomplete records, however, indicate that June rains are less common than in the region farther east, but slightly more common than in the region to the west.

With reference to seasonal distribution of precipitation, the National Forests of Arizona and New Mexico may be grouped as follows:

1. All of the Arizona Forests, except the Apache and the Chiricahua division of the Coronado.—This group is characterized by heavy winter precipitation but an extremely dry foresummer.

2. Western New Mexico and eastern Arizona, including the Gila, Datil and Zuni, Apache and the Chiricahua division of the Coronado

National Forest.—June rains are more common in this group than in Group 1, but on account of deficient winter precipitation, conditions are more favorable for an early fire season.

3. Lincoln and Manzano National Forests, exclusive of the Zuni division of the latter.—As in Group 2, winter precipitation is light. The month of May is dry, but June usually brings good rains. In average years the danger from fire is less than in Groups 1 and 2, but in dry years (when the June rains fail) conditions may become very serious.

4. Santa Fe and Carson National Forests.—Rains through May and June render this region reasonably safe from fire except in very abnormal years. On the whole these Forests should present the simplest fire problem in the two States.

RESULTS FROM SAMPLE PLOTS IN SOUTHERN PINES EXPERIMENTS

By Lenthall Wyman
Southern Forest Experiment Station

In 1915, S. T. Dana, then of the U. S. Forest Service, laid out five sets of permanent sample plots on the lands of the Urania Lumber Company at Urania, Louisiana. He was assisted by Henry E. Hardtner, President of the Company, and W. H. Thompson, of the Louisiana Conservation Department. The purpose of these plots was to secure data on the effect of fire and grazing on longleaf reproduction, the development of young stands of old-field shortleaf and loblolly pine, and the effect of thinning on young and middle-aged stands of shortleaf and loblolly.

In 1920 C. R. Tillotson, of the Forest Service, and R. D. Forbes, then Superintendent of Forestry for the State of Louisiana, made a re-examination and remeasurements of the plots.

A comparison of the 1915 and 1920 figures for the various plots follows.

"Holly" Plots

These plots were in a dense 11-year-old shortleaf and loblolly stand. The object of the Holly plots was to trace the early history of young shortleaf pine in old fields. One plot of one-eighth of an acre was left untouched as a check plot, and a second plot of the same size was thinned so as to remove 80 per cent of the total number of trees, or about 54 per cent of the original stand by volume. The 1915 thinning netted one cord of wood, 125 tomato stakes, and 190 bean poles, with a total value of $4.15, or $33.20 per acre. However, these figures should be discounted because practically 75 per cent of the cordwood was derived from one out-of-place wolf tree, and eliminating it the returns would be $3.43, or $27.44 per acre. All of these figures are hypothetical. Actually very little of the material was used. In some localities there would be a sale value for stakes and bean poles but in most localities the market will not absorb these classes of material.

The volume remaining on the thinned plot was 67 per cent of the check plot in 1915. By 1920 the ratio between the volumes of thinned and check plots was 77 to 100, showing a relative gain in volume of 10 per cent in 5 years for the thinned plot. If the same rate of increase is maintained for 10 years there would be practically as much material on the thinned plot as on the check plot, provided no further thinnings are made. Tillotson found in 1920 that the crowns had not yet closed, and he therefore made no further thinnings. By 1930 the material removed by the 1915 thinning would represent a net gain from trees which would otherwise have been killed or crowded out. Diameter and height growth also are stimulated by the thinning, and undoubtedly the quality of the trees which remain is higher than the average quality of the stand before thinning.

Summary of Holly Plots.

	No. of trees per acre	Average d. b. h. inches	Average height in feet	Volume per acre in cords [1]	Volume per acre in cubic feet
1915 (check)	1,784	3.1	23	13.71	1,096.8
1920 (check)	2,288	3.2	27	30.98	2,478.18
Increase (check) in 5 years	504	[2]1.2	[2]8	17.27	1,381.38
1915 (thinned)	[3]704	3.8	24	9.23	738.4
1920 (thinned)	752	4.8	34	23.85	1,908.38
Increase (thinned) in 5 years	48	[2]1.7	[2]14	14.62	1,169.98

[1] A converting factor of 80 cubic feet = 1 cord was used. (Taken from Bull. 24, N. C. Geol. Sur., by W. W. Ashe.)

[2] "Increase" figures are not obtained by subtracting the figures given for 1915 from those given for 1920, but are only for trees measured in 1915 and 1920 as well, eliminating trees which grew to measurable size during the 5-year period and which were not measured in 1915.

[3] After thinning.

"Maxwell" Plots

The Maxwell plots were slightly younger than the Holly plots and contained more loblolly. The trees were mostly from 4 to 10 years old.

There was a check plot of one-quarter acre, one quarter-acre plot was lightly thinned, and another was rather heavily thinned, although the better spacing of trees allowed the leaving of nearly as many trees on the heavily thinned as on the check plot. Thirty-one per cent of the trees in the lightly thinned plot were removed and 42 per cent in the plot where the heavy thinning was done. Owing

to the fact that in 1915 all trees below 1 inch d.b.h. were tallied by height and all trees over 1 inch d.b.h. by diameter without height accurate growth comparison between the 1915 and 1920 figures is not possible. The total volumes in 1920 were nearly the same on all three plots, but a considerable number of trees had no volume that could be recorded. The average height of the trees on the check plot and heavily thinned plot is about the same, while the lightly thinned plot has the advantage over the other two in diameter and height. However, there was a larger percentage of big trees on the lightly thinned area in 1915.

The check plot lost by crowding nearly 200 trees per acre during the 5-year period, the lightly thinned plot practically held its own, while the number of trees on the heavily thinned plot increased by about 600 per acre during this time. This large increase in the number of trees in the heavily thinned plot is accounted for by seedlings which came in where openings were made by the thinning operation and in openings in the original rather irregular stand.

Two hundred bean poles, valued at $2, were removed from the two plots in 1915, and further but very light thinning was done in 1920. As pointed out previously these values are assumed for comparative purposes only, as actually very little of the material could be utilized to advantage, no town being near. Under favorable market conditions these returns might have been expected. Although the stand was too young to yield much merchantable material in 1915, but of course better

Summary of "Maxwell" Plots.

	Trees under 1-inch diam.		Trees over 1-inch d. b. h.			Total volume in cords	Total trees per acre
	Number per acre	Height in feet	Number per acre	D. b. h.	Height in feet		
1915 (check)	1,076	7.2	564	2.2	....	....	1,640
1920 (check)	176	8.2	1,272	3.5	25.5	19.0	1,448
1915 (lightly thinned)	[1]432	6.4	[1]576	2.5	....	....	1,008
1920 (lightly thinned)	124	9.4	908	4.3	29.4	20.5	1,032
1915 (heavily thinned)	[1]596	6.5	[1]568	2.2	....	....	1,164
1920 (heavily thinned)	[2]552	8.1	1,236	3.7	25.8	18.7	1,788

[1] After thinning.

[2] Large numbers of seedlings came in where openings were made in thinning.

shaped trees resulted from the removal of part of the stand. However, it seems somewhat doubtful, in view of the negligible (in this case hypothetical also) financial returns from thinning done at this age, and the further fact that many trees removed by the thinning would undoubtedly have died and thus been eliminated from the stands, if this cutting was warranted at so young an age. The returns from the Maxwell thinning amounted to only $4 per acre as against $27.44 per acre for the Holly plots.

"Castor" Plots

The object of the Castor plots was to determine the effect of thinning on young stands of loblolly. Three one-quarter-acre plots were established in an old-field stand of loblolly 20 years old. They included a check plot, one plot thinned by removing 37 per cent of the trees, and a third thinned heavily by removing 58 per cent. In 1917 the check plot was wiped out by a summer fire, and was replaced by another in 1920. The two thinned plots have developed at about the same rate although there appears to be a slight advantage in favor of the heavily thinned plot. The lightly thinned plot has put on 19.3 cords of wood per acre in 5 years, and the plot which was thinned more severely increased in volume by 16.3 cords per acre.

The unfortunate loss of the check plot by fire makes it impossible to draw definite conclusions for this period on the effects of thinning in this type of stand. The increase in volume in the lightly thinned stand amounted to about 50 per cent of the 1915 stand in 5 years, while the heavily thinned stand, with less on it in 1915, made an increase of 52 per cent in the 5-year period. Apparently, stands of this age do

Summary of "Castor" Plots.

	No. of trees per acre	Average d. b. h.	Average height in feet	Volume per acre in cords	Volume per acre in cubic feet
1915 (check fire killed)	....	....	....	....	....
1920 (check)	412	7.6	62	53.54	4,288.3
1915 (lightly thinned)	[1]348	7.8	63	38.78	3,102.0
1920 (lightly thinned)	340	8.4	68	58.08	4,646.4
Increase in 5 years (lightly thinned)	—8	.6	5	19.30	1,544.4
1915 (heavily thinned)	[1]264	7.8	62	31.15	2,492.0
1920 (heavily thinned)	264	8.6	69	47.44	3,795.2
Increase in 5 years (heavily thinned)	0	.8	7	16.29	1,303.2

[1] After thinning.

not respond as quickly to thinning as do the younger stands like the Holly and Maxwell plots. A second thinning, in 1920, removed 9.06 cords per acre, or 15.6 per cent by volume of the stand, in the lightly thinned plot, and 8.73 cords per acre, or 18.4 per cent by volume of the stand, in the heavily thinned plot.

"Mayes" Plots

A blunder on the part of a laborer, employed after the establishment of these plots to shave off the bark above breast height in order to facilitate painting numbers on the trees, resulted in the removal of the bark at breast height also in many cases. The results of this thinning in mixed stands of loblolly and shortleaf on an old field are therefore obscured, and the data is not worth publishing at this time.

Roberts Plots

The Roberts plots consist of four quarter-acre areas, established in typical cut-over longleaf pine land, and treated as follows: One burned and grazed by horses, cattle and hogs; one unburned and grazed by horses, cattle and hogs; one burned annually in the winter and ungrazed; and one unburned and ungrazed. The plots were established the second winter after the heavy periodic seed year of 1913, and were covered with longleaf seedlings from that seed crop. They had not burned over since the seed fall. The annual fires which began on the burned plots in 1915 were set in every case during a damp day in winter, when vegetative activity is least.

For the first five years the results were, that in the grazed areas everything was destroyed by razor-back hogs except one or two advance-growth shortleaf pines. In the burned area, protected from grazing, fires had no effect on the longleaf seedlings in the first five years beyond retarding height growth. By contrast, what few shortleaf and loblolly pines there were succumbed to these early fires. The unburned, ungrazed area suffered no perceptible loss from any cause, and exhibited a greater rate of growth than where fires occurred, and also a few shortleaf and loblolly pines came in. This greater number of seedlings per acre was in spite of the fact that there were two or three large seed trees on this protected plot which reduced the number of seedlings under them through shading or root competition or both.

The fire of January, 1921, was the first to kill any seedlings on the repeatedly burned plot. Also for the first time, after six years of protection, the fire escaped and burned over a small portion of the

hitherto unburned plot. Finally at the suggestion of Dr. W. H. Long, Pathologist, Bureau of Plant Industry, the count and measurement of trees affected by a leaf-spot disease were kept separate from those of healthy trees. This was during the count in September, 1921.

There are several points to consider in determining the effect of fire. In the first place it has reduced the number of seedlings per acre, so that there are only 81 per cent as many trees on the burned as on the unburned area. In 1915, there were 87.5 per cent as many trees on the burned area as on the check plot and 11.7 per cent of the trees which were on the burned plot in January, 1921, were destroyed by fire at that time. Furthermore, 9.1 per cent of those not destroyed were killed to the ground and have since sprouted. Whether or not these trees will ever amount to anything is a question. It seems probable that they are so weakened that they will soon die. Eliminating these sprout trees, there are left only 4,387 trees per acre on the burned area as against 5,799 on the unburned plot.

The second conclusion is that fires seriously retard the growth of those trees which do not succumb. Thus the average height of all longleaf pine trees on the burned plot, exclusive of the sprout trees, is 11.0 inches in September, 1921, while on the unburned area the longleaf trees average 21.6 inches, or nearly twice as tall.

In the third place it is apparent that when the trees are from 6 inches to 18 inches tall they are most liable to be killed or seriously injured by fires. The average height of the trees killed by fire was 12.1 inches, and 87.5 per cent were in the 6-12 inch and 12-18 inch height classes. No trees over 2½ feet in height were killed by fire on the area which had been burned each year, and only five were killed of less height than 6 inches, although nearly 400 seedlings 6 inches or less in height were present on one-fourth acre.

The fourth conclusion is that the accumulation of débris and the rank growth of grass and small forage plants, where grazing and fires are excluded as compared with areas where grazing or annual fires occur, constitutes an increased fire hazard. In the small sector where fire accidentally burned after six years of protection, 38.7 per cent of the trees were killed or caused to sprout, while on the area burned annually the smaller amount of inflammable material resulted in the death or sprouting of only 20.8 per cent. Furthermore, the damage in the protected area might have been even more severe had the fire occurred a year earlier, when the average height of the trees was less.

When the fire occurred the majority of the trees were above the height of maximum liability to fire killing which is about 12 inches. The average height of the killed trees was 22.6 inches.

It has been suggested that cattle grazing, with hogs eliminated, would be a benefit, in that the amount of inflammable material would be considerably reduced.

The fifth conclusion is that the leaf-spot disease is important on the young trees, probably weakening their resisting powers, retarding their growth, and certainly killing some of them. One and nine-tenths per cent of the trees on the protected plot were killed by the disease this year. This is not a serious factor where about 5,800 trees per acre are left, and yet cannot be entirely ignored. Any similar loss on the repeatedly burned plot was not separable from the fire loss.

In the sixth place, this disease seems to render the trees less resistant to fire. This deduction is based on the fact that after the fire of January, 1921, 43 per cent of the trees were diseased on the burned plot and 66 per cent on the unburned. What became of the difference of 23 per cent if they were not killed by that fire? Further emphasis is given when it is considered that the taller trees (on the protected plot) are less susceptible to disease than the smaller ones where fires occur annually. Another theory, advanced by Dr. Long, is that fire controls the disease which seems, on the whole, more tenable except for the fact that on the area burned by accident the surviving diseased trees were only 28 per cent of the total as against 66 per cent on the unburned. The logical conclusion is that the percentage of diseased

Summary of Roberts Plots.

Species and condition of young trees	Seedlings per acre		
	Area repeatedly burned	Area protected since 1913	Area protected 1913-21, accidentally burned, 1921
Longleaf pine—			
Vigorous	2,303	1,984	3,010
Diseased	2,084	3,815	1,387
Sprouts	438	0	443
Total alive	4,825	5,799	4,840
Killed by fire	640	0	2,331
Killed, other causes	4	113	0
Shortleaf pine, alive	4	26	29
Loblolly pine, alive	0	96	30

trees killed by fire was much greater than of the healthy class. It is believed then that fires may control the disease to some extent but at the expense of considerable numbers of infected trees which are killed by them.

In summing up, tentative conclusions on the basis of the measurements and counts of September, 1921, on the Roberts plots are as follows:

1. Careful winter burnings, begun when the seedlings are a little over a year old, do not kill longleaf pine until the majority of the seedlings have reached six inches in height. This is about the eighth year in the case of repeatedly burned stands. After this height is reached a considerable mortality, between 10 and 20 per cent, may be expected in each fire.

2. Repeated fires stunt the growth of seedling trees, reducing the rate of height growth by 50 per cent for six years at least.

3. Six to 18 inches represents the stage of growth for longleaf pine seedlings when fires do the maximum amount of damage.

4. Complete protection from fire must be continued for more than 6 years where grazing has been excluded. Otherwise the increased amount of inflammable material resulting from the no-grazing policy will cause a disastrous fire.

5. The leaf-blight disease has killed a number of seedling longleaf pines and is a factor in obtaining reproduction.

6. This disease which renders infected seedlings more susceptible to fire than are healthy seedlings may be partly controlled by fire.

IDEAS ON NATIONAL FOREST POLICY[1]

By Austin Cary

As far as views and inferences rather than facts are stated herein, they are personal, not official. I have called myself a forester, worked in timber in various capacities, and done more or less thinking on related matters for the past thirty years.

As stated to the committee at New Orleans, I am glad to see a body of broadly representative men, as distinct from those of technical training and interest, taking hold of this matter. It is worthy of it; it is time action was taken; the concentrated, technical man in a matter as broad and involved as this may not be safe in counsel.

To date, however, the man of special interest has been about the only one who would give serious attention to these matters. That puts it up to those now coming to the reenforcement of the movement for better treatment of forest land in the United States to stay with the job.

To the main task of the committee, as I understand that to be—the outlining of legislation required to secure ends recognized as desirable, adjustment of relations in that field between State and Government, and planning for provision of funds that may be required—I do not think I can contribute directly to any material extent; my thinking has not run in those channels. To set limits to a problem and give relative weight to different features is also worth while, however, and it may be that I can do something in that direction.

1. I agree with Chief Forester Greeley that control of fire in our wooded lands is the first thing to look after, and that when this is done, timber production and reproduction will follow on vast areas spontaneously and in generous amount. No man can tell how much of our need for timber the effective handling of this one element would meet, but a good share of it at any rate; then behind reasonable safety from fire there is bound to spring up a variety of other productive measures. As for the organization and expense involved, that seems clearly to be a cooperative proposition. In most circumstances the owner of land

[1] Written for the Committee of the National Chamber of Commerce.

cannot do the work alone, nor, on the other hand, should the stingy and hang-back kind of man be allowed to endanger others, or himself go cost free. Ratings have been proposed on which it is thought expense of fire control can be shared equitably by owners, the State, and the general Government, and I do not care to approve or criticise any. An idea, collateral to the main one of this topic, seems worthy of statement—that some areas of land are so hard to protect from fire and of so little productive power that they are not worth the expense involved.

2. The next most pressing thing in my opinion is to lay the foundation for a large area of public forests—National, State, municipal, any that can be put through. That judgment does not arise from any predilection for collective as against private enterprise, but from the fact that the experience of mankind, as I understand it, teaches the necessity of the measure. I am as much a believer in private forestry as any, I think, but on some types of land and for some classes of products, public ownership and the type of management it brings are essential.

That, I realize, is putting up quite a proposition, but what we are trying to do, I take it, is to ascertain clearly what is before us if this matter is to be fixed up right. Two or three collateral points may be noted in passing: First, that exchanges of land, and of stumpage for land, in connection with National Forests are in line with this idea; second, that public forests promise in this country as in Europe to provide generous public revenue; third, that the land areas required for such forests will be acquired more cheaply the quicker we go at the job.

The two things above noted seem to me not only the biggest and most important in the field under consideration, but in a way the simplest, by which I mean that in my opinion men will most readily agree to their desirability and gather to their support.

3. Regulation of privately owned forest land by law or public administration is a thing which naturally does not appeal to me, my position being that we want as little of it as we can get along with. I have, however, supposed that, paralleling the experience of older countries, we should come to use more or less of it at some time. As an indication of the time when it was needed and could be successfully carried out I have had in mind this sign—that men of experience, standing and judgment, informed of the facts but outside the technical interest,

should believe that the time has arrived and stand ready to support and guide it. Right-minded men in the lumber industry were included in that view.

Adequate and equitable fire control involves compulsion to some extent; so does the seed-tree law of Louisiana, and certain laws on that and other matters now in force in the New England States. I believe in these, as far as they are found to work well, in their enforcement and extension on the same grounds. I note that they relate to fundamentals, are general in application, and simple; moreover, local support based on general intelligence and special education, also a really competent force to administer them, are behind these measures or are assumed.

Certain other things, to the best of my understanding, I do not believe in. I don't want to see forestry thrust on the country as prohibition was. Management of the timberlands of this country by a bureaucracy in Washington, I don't want; it looks undemocratic, impracticable, and dangerous. I think we had better suffer a good deal from timber shortage rather than try these things.

Between these two extremes is a large field, in which important interests are at stake, on which I myself am not altogether clear. The best I see to do now is to state some things about which I do feel reasonably so.

4. Education is an undeniably good thing, necessary in any case; and despite what some men say, we haven't had nearly enough of it. Can't the committee outline plans for further effective educational work?

5. There is, in my opinion, a large field in which a pretty good type of forest management is profitable financially, and the area over which that is true is increasing. I have for years been impatient with my fellow foresters that they have not seen that, gone at it themselves with their own or borrowed money, and shown other men how to do it. As far as that line is developed it seems to meet the forest problem of the country in the easiest and most natural way possible. If, therefore, the committee think as I do and will point out the fact with the force of their authority behind it, a good many fruitful enterprises might be set in motion.

6. You have heard and thought much of the matter of taxation. It is important and I do not mean to minimize it; I should of course be glad to see established in this country, in that and other relations, logical and scientific methods of taxation. These may come slowly,

however. Meanwhile, because misapprehension often checks progress, it may be worth while for me to explain that I think some have not always got these things quite straight and how.

The men who put up this along with every other conceivable difficulty with the purpose of proving an alibi and preventing any action that may possibly interfere with interests or plans of their own, need be given no more attention here. But perfectly honest men, in New England for instance, on the basis of isolated experience, have said that we must have radical tax reform before we can do anything worth while in forestry. I do not think so, and say that on the basis of ownership in seven different towns in Maine and familiarity with the matter in the State at large. Low valuation takes care of the matter there and our people and authorities are open to that because they recognize the burden of the usual form of taxation as applied to timber and because so many own property of this kind.

On the other hand, taxation is sometimes so heavy in proportion to resources, on account of extravagance, graft sometimes, the bad layout of communities, low earning power of men, that no reform less sweeping than that of the community as a whole can afford much relief. Conditions of that sort, also taxation directed at big concerns because they are conspicuous and no bond of appreciation exists between them and the majority of the people, were behind a good deal of what you heard at New Orleans.

This probably is true—that large, permanent, thoroughly organized enterprises of private timber growing will not be undertaken in advance of favorable and secure adjustments on this head. My point is simply this—that in economical and right-minded communities men can do considerable at raising timber today if they want to for all of the tax.

7. It seems to me that the times perhaps call for the prevention of "devastation" of timberland, or some of it, and that we ought soon to be in shape to do that. I wish to define the term, however. Devastation in the sense that I think the American people are concerned with and anywhere near ready to forbid and prevent, is not simply clean cutting (that perhaps more often than not is really the best forestry); it is so treating land, by a combination of cutting, fire, or what not, that for a very long time to come without heavy expense for reclaiming it cannot be counted on to produce anything of consequence for human use; or secondly, that heavy damage to others' property or the community follows.

Not a great deal of that goes on, but some does. Purchase is one remedy and is now being applied in the mountain forests. Where that is not available, and the matter turns, as it seems to oftentimes, on as simple a matter as the leaving of seed trees, I would say that it ought to be prevented and that any cost involved should be borne by the land owner.

The matter in the last eight paragraphs, it may be remembered, bears some relation to topic 3 (regulation) above. I have gone as far in defining my ideas on that point as I am able; perhaps too I have reached the limits within which it is a practical question. If so, business will go along in freedom and unhampered within limits set, not by official judgment based on technical standards, but by the point at which undoubted and substantial damage to the general interest is sustained.

Other things that occur to me as worth saying relate to the South.

This section is only now fairly beginning to learn that timber is not everywhere and always to be taken for granted like air and water, but is a thing that in more or less degree has to be provided through forethought and effort.

I mentioned at the hearing the widely prevalent habit of using winter fire in the supposed interest of grazing, and that regardless of ownership and the wishes of the owners of land. I also mentioned the deep rooting of the custom. This practice on large areas prevents reproduction of timber; after they are well started the southern pines are rather hardy against fire. This in my judgment is true also in considerable pine territory—that controlled and properly timed fire is in present conditions the best practical safeguard against extensive damage from the same source.

Some general characteristics of the South as compared to northern communities are widely understood. In general there is less respect for property, for law, and for others' rights. In certain sections there is dense ignorance and a very low type of life all round. The plane of public life is not so high but that the last legislature of one Southern State was apparently in control of the free-range interest while the tax system of another is run in such a way that it is very precarious to do business of any kind. As for the lumber industry, it seems to me to contain some very hard men, but it may also have been true that they have had to be hard to maintain their rights and get their work done.

Some residents say that the only hope of progress in forestry is in the authority of the United States. We have, on the other hand, in the history of the present National Forests and of tick eradication, examples of how that actually works, and I for one do not like the indications. Tick eradication went slow and hard; vats were blown up in numbers, and the work at best, I think, was carried out only imperfectly. In respect to the National Forests, there is still large failure to appreciate and cooperate with their purpose, even to respect the property of the whole people as there embodied: last summer advantage was taken of an extremely dry time to cripple telephone communication and burn one division of the Florida Forest. Too much looking to Uncle Sam therefore on the part of influential southern people savors to me of passing the buck.

Education I am of course in favor of, of establishment of forests, State and National, as far as may be; also of cooperation with every progressive movement and force. Speaking broadly, however, my opinion is that time must be allowed although the cost of that may be greater than we like to think of. The South has in its keeping the greatest of our potential forest resources, yet the balance of the country will do well, in my opinion, to exercise a degree of forbearance; it may be considered in fact to owe that to the South. On the other hand, I feel that when sufficient preparation has been made there will be a larger field than elsewhere for the use of authority, or compulsion, for reasons that will have been gathered from the above.

One of the most effective forces, especially from the viewpoint last indicated, I have thought may prove to be the self-interest of the private land owner. For instance, that interest is just now in certain territory engaged in establishing individual possession of wild land through the fence. Suppose the owner came to realize that, in addition to pasturage, young timber and reproduction are of value to him. He would then be on the spot, with an organization, practiced in maintaining his rights, in better shape, I think, to do that than any other agency could be, while his rights in this case would embody also the interests of the community. In this and other directions I have thought strong and progressive land owners might serve as one of the most useful agents of progress and my personal work in the South is in line with this idea. In spite of the general tenor of what has been said, conditions are not at all unfavorable sometimes.

State organizations aimed at fire control are spreading and should do

much good. Perhaps useful laws restricting the naval stores industry can be devised when it appears that any State is ready for them; that will be shown for one thing by assent of enlightened turpentine men themselves. Laws of another kind, too, have a large bearing on this head and are gradually extending in the South, requiring stock to be confined within fences. My personal attitude toward National legislation may be gathered from a statement made last spring to representatives of the Southern Pine Association, that I thought operation of the Snell bill ought to help them and their communities by promoting solid advances and at the same time discourage freak and strike legislation in the different States.

Perhaps before closing I can develop one more idea in a way that will be worth while.

There exist in this country (and they command extensive means of expression) ideas bearing on this matter of our forest interests that are technical and detailed. That is to say, instead of forestry (timber growing) being a simple matter, man's part in it consisting in maintaining a few essential conditions for nature, in the minds of the men referred to it is a complicated structure of methods, precedents, history, etc.—these mostly derived from Europe and not as yet either proved out here or familiar to our people at large. These men think technically and in detail. They want to oversee and direct the process of seed production and germination, to see trees grow according to some site classification; to thin every stand two or three times. Lumbering with them is a thing out of date; instead they would have the final stand removed at financial maturity.

That has utility in its place, no doubt, but it does not seem to me the thing to guide us in the present circumstances. At the present juncture the American people, it strikes me, are more likely to absorb and act on a few simple ideas. Really wasteful or destructive practices, when they identify them as such and find they are needless, I hope and believe they will put an end to; also, as before stated, it seems to me they will act largely on the idea of public forests. Now, suppose those two things were going ahead and that as a result of the actual carrying out of the first measure, we had, as I think we would, vast bodies of young timber coming on in this country, couldn't we afford to feel fairly easy in mind, enough so that we could take time to do the balance of the job thoroughly and in order? Couldn't we also trust meanwhile to the sense and interest of one and another class of our citizenship to attend to a lot of the detail business? It strikes me we could. My judgment consequently, whatever it is worth, is for a simple and strongly weighted program.

REVISION OF A REPORT ON A FOREST REGION AND TYPE CLASSIFICATION FOR NEW ENGLAND

By the Committee on Research, New England Section of the Society of American Foresters

In the February, 1922, number of the Journal was published an article concerning a forest region and type classification for New England.

This classification has been subject to important revisions both as to regions and types. For this reason the first 2½ pages of the original article as revised are reproduced here and are followed by a list of corrections to be made in the type descriptions of the original article.

The purpose for which this regional and type classification is made is to establish a basis for studying the production and management of the forest areas in New England and for systematizing and standardizing silvicultural practice as applied on those areas.

As used throughout this report the term "forest region" is understood to apply to a large area where, when settlement began, the chief species of trees were the same with similar conditions of climate, topography and other natural factors; where now, the density of population and available markets for forest products are fairly uniform. A forest region must include more than one forest type and often the same forest type is found in more than one forest region.

In studying production and standardizing silvicultural practice, the forester must deal with the forest present on the area. Hence "forest type" for the purposes of this report is considered to be the cover type. This conception of forest type (i. e., as the cover type) is defined by the Society of American Foresters in Forest Terminology, Journal of Forestry, Vol. 15, p. 80, as follows: "A cover type is a forest type now occupying the ground, no implication being conveyed as to whether it is temporary or permanent."

According to the classification and map issued by the U. S. Forest Service, entitled "Natural Forest Regions of North America," New England has part of its area in the central forest and the rest within the northern forest. This division does not accurately portray the

forest conditions of New England. Hence the section has adopted instead a separation into four natural regions as follows:

1. *Spruce and Northern Hardwoods Region*, chiefly in the higher and less thickly settled parts of northern New England and western Massachusetts, characterized by beech, hard maple, yellow and paper birches, spruce, balsam fir, northern white cedar, tamarack, hemlock, and scattering white pine.
2. *White Pine Region,* chiefly at lower altitudes and in the more thickly settled parts of east central New England, also in northern Connecticut and in western Vermont, characterized by white pine and a wide variety of hardwood species.
3. *Connecticut Hardwoods Region,* chiefly in the more thickly settled parts of Connecticut between the white pine region and Long Island Sound, characterized by oaks, chestnut, hickories, and yellow poplar.
4. *Cape Cod Region,* in Massachusetts, a detached portion not thickly settled of the coastal plain of the South Atlantic States, including Nantucket, Marthas Vineyard, the Elisabeth Islands, Cape Cod and adjacent parts of Plymouth County, characterized by the absence of white pine and the presence of pitch pine, scrub oak, and post oak. Chestnut, chestnut oak, and hickory are not found in the oak type in this region.

The approximate position of the regional boundary lines is indicated on a map (not reproduced here) and will be fixed more exactly as data become available.

For the purpose of studying production and standardizing silvicultural practice the cover type rather than the region should be the unit. It is evident to one acquainted with New England conditions that instances are common of the same cover type occurring in two or more forest regions. The regional division, however, is not useless. It may appear on investigation that the same cover type requires different treatment and shows different production in each forest region.

A list of twenty-two cover types is submitted. The committee has attempted to make the types as few as possible consistent with the range of conditions. The types as given in the table are divided into coniferous, hardwood and mixed types. Their occurrence by forest regions is indicated. A separation is made into types of major, secondary, and minor importance, considered commercially or in area occupied. When a type is found in more than one region these terms, major, secondary and minor, refer to its relative importance in New

Table showing the names and indicating by crosses the regional distribution of the forest cover types of New England.

Type		Forest Regions: Spruce and northern hardwoods	Forest Regions: White pine	Forest Regions: Connecticut hardwoods	Forest Regions: Cape Cod
Cedar types	Northern white cedar swamp[1]	X	....	....	....
	Southern white cedar swamp[2]	....	X	X	X
	Red cedar[2]	....	....	X	X
Fir types	Fir flat[2]	X	....	....	....
	Fir slope[2]	X	....	....	....
Hemlock types	Hemlock[2]	X	X	X	....
Pine types	Pitch pine[2]	....	X	X	X
	WHITE PINE	X	X	X	....
	Norway pine[2]	X	X	....	....
Spruce types	Old-field spruce[1]	X	....	....	....
	SPRUCE FLAT	X	....	....	....
	SPRUCE SLOPE	X	....	....	....
	Spruce swamp or bog[2]	X	....	....	....
Hardwood types	GRAY BIRCH	....	X	X	....
	NORTHERN HARDWOODS	X	X	....	....
	OAK	....	X	X	X
	TRANSITION HARDWOODS	....	X	....	....
	Birch and poplar[2]	X	....	....	....
	Hardwood swamp[1]	X	....	....	....
Mixed types	Pine and hardwoods[1]	X	X	X	....
	SPRUCE AND HARDWOODS	X	....	....	....
	MIXED NORTHERN SOFTWOODS	X	....	....	....

[1] Types of secondary importance commercially or in area occupied.

[2] Types of minor importance commercially or in area occupied.

Regional occurrence of a type indicated by crosses X.

TYPES OF MAJOR IMPORTANCE COMMERCIALLY OR IN AREA OCCUPIED.

It is assumed that the mixed types contain (based on area occupied by the upper crown canopy) 20 to 80 per cent of conifers and 20 to 80 per cent of hardwoods; while the two types between which a given mixed type is intermediate contain less than 20 per cent of the conifers or of the hardwoods in question.

England as a whole with no implication as to its relative importance in any one region.

REVISIONS TO APPLY TO TYPE DESCRIPTIONS

Northern White Cedar Swamp Type—

Line 2. After "occidentalis" insert "Pure or in mixture with."
Line 3. For "usually" read "sometimes."
Line 4. After "and" insert "very rarely."
Line 8. Delete whole line and substitute: "Importance—Small in area but commercially important particularly in Maine."

Pitch Pine Type—

Line 2. After "Oak" add "In the Cape Cod Region often a few pitch pine with a large percentage of scrub oak."

Old-Field Spruce Type—

Line 2. After composition change to read, "Second growth spruce either red or white, pure or with a small percentage of other conifers.

Spruce Flat Type—

Line 2. After "species" insert "generally mixed."
Line 2. After "with" insert "a few additional hardwoods but."
Line 9. After "Importance" delete "It is the third most important type." Substitute "It is a type of large importance."

Spruce Swamp (or Bog) Type—

Line 3. For "often" read "seldom."
Line 4. After "Alders" insert "Ground cover usually sphagnum."

Mixed (Northern) Softwoods—

Line 8. After "Importance" delete statement and substitute "Will be recognized by many foresters as a major type."
Insert before Pitch Pine Type:

Norway Pine Type—

Composition—Eighty to one hundred per cent Norway pine with varying percentages of white pine and pitch pine.
Origin—Seed.
Location—Sandy soils or poor and shallow soiled rocky areas.
Importance—Found infrequently in northern and central New England.

The Committee on Research, New England Section of the Society of American Foresters.

R. C. Hawley, *Chairman;*
E. I. Terry,
K. W. Woodward.

REVIEWS

Lumber: Its Manufacture and Distribution. By Ralph Clement Bryant, Professor of Lumbering, Yale Forest School. John Wiley & Sons, New York City, July, 1922. Pp. XXI + 539, figs. 156, tables 50.

The lumber industry is the only large industry which is not represented by a series of text books covering all its phases, and until Bryant's "Lumber" appeared teachers had to glean reference material bearing on this subject from many sources—largely Government bulletins and trade journals. In particular did young men not attending forestry school but desirous of learning the lumber business find it extremely difficult to pursue their studies in an orderly manner. Now they will find it considerably easier, for under one cover the author describes very thoroughly the manufacturing processes from the time the logs are received in the saw mill pond until the lumber is ready for use in a finished product. In addition about a fourth of the book is devoted to a discussion of lumber markets and marketing. The subject matter is presented in a very logical way and is well illustrated. To the student in lumbering it should give a very clear conception of the manufacture of lumber, and if he desires to go further in his studies, seeking greater detail, he will find numerous references given as footnotes and a ten-page classified bibliography in the appendix.

The book is divided into three parts: I, The Manufacturing Plant; II, Lumber Manufacture; and III, Lumber Markets and Marketing, preceded by an introductory chapter in which is given a brief history of the development of lumber manufacturing machinery and methods together with a general picture of what is to follow in greater detail.

Part I includes chapters on the character, location, and arrangement of the manufacturing plant; log storage; sawmill equipment; saws; lumber handling and transfer equipment; and sawmill power plants. In each chapter all the important methods and machines or devices are given ample space and where there is a choice between several processes or devices the advantages or disadvantages of each are listed or discussed. For example, in the chapter concerning the handling and transfer of lumber there are described the various types of wheeled vehicles, such as two and three wheeled buggies, wagons, tracrors,

motorized carriers; monorail systems; several types of cranes; rollers and chains; cableway systems; and small rail cars. The conditions to which these methods and devices are suited along with capacities and specifications are discussed in many cases with reference to actual installation. The author might well have included a discussion of the particularly satisfactory cable tramway system described in the July, 1918, *Timberman,* page 32B.

Part II, Lumber Manufacture, embraces chapters on methods of sawing, edging, and trimming; seasoning of lumber; the remanufacture of lumber; lumber products (covering their size, patterns, and basis of grades produced); mill refuse and its disposal or utilization; fire prevention and insurance; and sawmill labor. In these chapters may be found descriptions and discussions of the merits of the various methods of sawing up logs, edging and trimming the lumber, and the technique of yard piling and kiln drying to season lumber with as little loss as possible. In the seasoning chapter is much material not available elsewhere, but it is a rather brief chapter for this important subject. The author has evidently left the more detailed and technical discussion to the texts and bulletins to which he refers. In the chapter on labor are discussed the character, housing and efficiency of labor, methods of payment, unions, accident prevention and compensation acts.

Part III, Lumber Markets and Marketing, includes chapters on lumber trade associations, lumber grades and their inspection, transportation, domestic and foreign markets, and lumber tariffs. Each important association is here briefly described. Association activities, historical and as affected by recent legal proceedings, are given considerable space. To the formulation of rules for the grading and inspection of lumber and the enforcement of these rules are devoted fifteen pages. In the transportation chapter are discussed rail and water transport with notes on tonnage, capacities, rates, classification, and the milling-in-transit privileges. Both foreign and domestic markets are covered in considerable detail, and each of the tariff acts are discussed in so far as they concern lumber. The book was, however, published just before the passage of the Fordney Act. Perhaps the author despaired of its ever passing.

In the seventy-nine page Appendix are an extensive bibliography; a glossary of terms used in lumber manufacture and distribution; and

such tables as lumber grades produced from various woods, standard sizes and weights of lumber, lumber production, etc.

This is the author's second text book, his first being "Logging," published in 1913. Needless to say, the subject of logging is given no space in the newer book. The reviewer has adopted "Lumber" as a text in his courses bearing on the lumber industry and has found it admirably adapted to his class room needs. The book should also find a wide field of usefulness among lumbermen for reference purpose, and among young workers in the mills who desire to learn their business in its entirety rather than only the branch in which they are employed.

E. F.

Trade Course in Log Scaling for Idaho Woods, State Board for Vocational Training. Volume V, No. 5. May, 1922.

This pamphlet marks a distinct advance in both the literature on scaling and in its form of presentation for purposes of instruction. The introduction on vocational training gives a clear and sane summary of the functions of a trade school, and the advantages of instruction under systematic direction as contrasted with "taking to the woods as fast as your legs will carry you." Section X is devoted to a discussion of the methods of teaching log scaling in which those advantages are further brought out and contrasted with the acquisition of a trade by "absorption." Section I is especially clear and well arranged for instruction. The materials in construction of log rules, evidently taken from Graves' Mensuration, are boiled down to digestible form. It is not explained how deductions for normal defects are to be made, separately from slabbing waste. Judson Clark included normal crook as a part of the slabbing deduction.

The statement that "official (statute) approval of certain log rules add to the general confusion" is unfortunate, though quoted from the above authority. The official adoption of the Scribner Decimal C rule has greatly simplified scaling in the states using it and in the Forest Service, and in general it is the inaccuracy of rules, not the attempts to secure uniform use, that has caused confusion.

New data are given on the origin of the Doyle log rule which, however, could be more strongly condemned. A new rule of thumb for board feet, Scribner Decimal Rule is given on page 7.

The only real criticism of this section is for giving the formulae for several log rules which are inaccurate and obsolete for board foot

measure and should be buried in oblivion instead of perpetuated by fresh references in standard publications. Of these the Ropp rule is the worst. The rule of thumb on which it is based is wholly inaccurate and there is a corresponding inconsistency between the scale of small and large logs which is the most glaring fault of a log rule.

The Square of Three-fourths log rule is obsolete, and like the Square of Two-thirds rule, also quoted, is a rule for cubic contents squared and, as the author himself quotes on Page 3, is fundamentally incorrect, over-scaling small logs, and under-scaling large ones. Probably the idea is to give five or six rules based on formulæ for classroom practice. In this case, the iniquitous Doyle rule, which was given, might be justified, but hardly an equally bad rule not in common use. The British Columbia log rule is sound and also in use.

II. In Section II, the writer has indulged in reminiscence, some of which is not of great instructional value, though interesting to read. The progressive development of scaling methods is good information, but obscured by the historical treatment.

III. This section gives the characteristics by which the species of wood are identified.

IV. Since these scaling instructions follow the standard practice of the Forest Service in all respects, they are consistent, specific, and clearly expressed. The author leaves no point in doubt, but illustrates each case by diagram and example. The influence of the minimum length of board, 6 feet, is emphasized.

V. This section is a scientific and accurate description of the different species of wood-destroying fungi and their effect on the log or bole, with means of identification and gives a basis for scaling defects due to rot.

VI. In this section, specific information is given as to the average dimensions and character of the rot or defective portion resulting from the presence of punks and this is made the basis of deductions required in scaling. Numerous illustrations add to the value of this discussion.

The methods of scaling crooked logs are explained in detail. Other sections, VII and VIII, deal with reports and with check scaling.

Scaler Knouf, from a lifetime of experience, has his subject well in hand, and by reason of long practice under standard scaling instructions drawn up in 1916 by the Forest Service, which laid down rules covering nearly all disputed forests, he has been enagled to treat the whole sub-

ject in an authoritative way, which is admirably adapted to trade education.

As to the accuracy of the methods of scaling discussed, the entire nature of scaling should be governed by rigid definitions as to standards, and the application of rules for scaling intended to secure a standard of uniformity as between different men. In only one respect, apparently, does this standard depart slightly from the goal of accurately scaling the straight and sound contents of logs, and that is in regard to the much discussed problem of center rot. Tiemann's studies show that the method of squaring the diameter, deducting one-fifth and finding board feet contents is inaccurate, varying from 87 to 110 per cent of true loss in sawed contents and that the formula:

$$2/3\ (D+1)^2\ \frac{L}{12}$$

gives the correct result. But as this formula requires a slightly different procedure from that used in computing interior defects in other cases, and as the variation from accuracy is not over 13 per cent, it is probable that the present practice will continue. As conforming to this practice, the text is correct as it stands.

The entire text marks a new highwater mark in discussion of scaling practice.

H. H. C.

The Export of Western Red Cedar to Japan. By Donald H. Clark, Secretary-Manager, Rite Grade Shingle Association. University of Washington Forest Club Quarterly, The Forest Club Annual, Volume X. Seattle, 1922. Pages 43 to 59, figs. 4.

Japan in recent years has been a very active buyer of western red cedar and Port Orford cedar, to such an extent in fact as to arouse our curiosity as to what she is doing with it. During the recent depression lumbermen hailed the Japanese demand as the "one bright spot in the lumber industry," while jingoists, ever ready to suspect the motives of Japan, accused her of laying in large supplies of cedar for airplane stock and other military and naval purposes. One traveler, also, reported that Japan had closed her own forests against further exploitation because they are not sufficiently extensive to meet home demands without impairing their continuous productivity.

Mr. Clark has done us a valuable service by analyzing in his paper the export of our cedar to Japan and for relieving our fears, for he

tells us that the Japs use our western red cedar almost exclusively for house building, and cites a number of reports from consuls and representatives of American lumber and shipping firms to bear him out. However he calls our attention to the really serious effect these heavy exports are bound to have on our own domestic needs. Western red cedar furnishes 85 per cent of all the shingles used in the United States and each year these shingles cover thirty square miles of our roofs and side walls. It is important therefore that our domestic needs are not jeopardized because of too heavy exports.

Japan, it is pointed out, is suffering from an acute shortage of housing facilities; furthermore, some of the larger cities are being rebuilt. Japanese houses are largely built of wood, cedar being the preferred wood. It happens that our Port Orford cedar and western red cedar are very similar to native Japanese species, lending themselves as readily to both exterior and interior uses. Houses are not painted, the exterior being allowed to weather while the interior is sandpapered, rubbed smooth and left unstained. Japanese forests are comparatively inaccessible; this and the primitive methods of logging make the raw material cost more than logs brought from America. Japan imports our cedar largely in unmanufactured form, because logs and bolts are permitted to enter free while manufactured material must bear a 25 per cent ad valorem import duty. Furthermore, shipment of manufactured lumber is attended with considerable loss due to breakage, staining and splitting in handling.

"Jap cedar," as the export logs are known, demands a fairly high grade of material. Such logs are often picked from rafts at the shingle mills. This procedure has given rise to what amounts to a new grade of logs—skimmed logs. This results in a poorer class of material for the shingle weavers. An instance is cited where a shingle mill crew went on strike and refused to work on the material from culled rafts. Already the Jap demand has brought about a shortage of raw material for the shingle mills.

The States of Oregon and Washington contain the only stands of western red cedar fitted for the large-scale production of shingles and lumber. The total stand in these States is given as 33,829,000,000 board feet and the average annual cut for shingles and siding as 833,728,000 board feet, making it appear that the supply would last forty years. This cedar, however, grows in mixture with other species, principally Douglas fir, and its rate of cutting will depend on the demand

for this latter species. Furthermore much of it is inaccessible, so that the estimate of forty years should be greatly exceeded but at the expense of a diminished annual cut, which may eventually be inadequate to meet the demands of the shingle industry. Opinion is divided as to whether or not the export of cedar on a large scale should be restricted by an export duty or otherwise. Those who are engaged in the export of cedar claim it is justified. We cannot expect the timber holder to sell his product in the United States for much less than he can sell abroad. Those who are opposed to the heavy export of cedar argue in the main that it deprives the American working man of employment. One exporter who is also a shingle manufacturer believes the export of cedar to be a fine balance wheel for the shingle industry. The raw material sold abroad is, however, the writer points out, not from a surplus but is a part of our own very limited supply and therefore a matter of national concern. When this or all that is economically accessible is gone millions of dollars of capital invested in cedar mills will be wiped out. EMANUEL FRITZ.

The Relative Cost of Making Logs from Small and Large Timber. By Donald Bruce, Associate Professor of Forestry, University of California. University of California Publications, College of Agriculture, Bulletin 339, 1922. Pages 16, fig. 1, tables 14.

The title of this bulletin will at once command the attention of logging engineers and lumbermen. The author describes his study as "a general investigation of the factors affecting the cost of logging," and gives the outstanding result as a "proof of the excessive cost of logging small timber as compared to large, when methods and machinery adapted to the latter are used." In italics he adds "it costs three times as much per M b. m. to make logs from 18-inch as from 48-inch trees, and that below that diameter the costs undoubtedly rise rapidly with each further decrease in size."

The study was made in the Sierra Nevada pine forests of California on the operations of three companies where the methods of logging and the surface conditions are representative of the region, but the results should be indicative of the spread of similar costs in regions quite removed from the Sierra pine region.

Falling, limbing, marking and bucking were the specific operations studied. Figure I shows graphically how the cost of each of these is affected by tree size, e. g., selecting five sizes from Table 1 accompanying the graph:

Cost Per M B. M.

Tree diameter....	18 inches	24 inches	30 inches	40 inches	48 inches
Falling	$0.77	$0.55	$0.41	$0.25	$0.19
Marking	.18	.16	.12	.06	.03
Limbing	.08	.10	.14	.14	.11
Bucking	1.02	.58	.40	.33	.33
Total........	$2.05	$1.39	$1.07	$0.78	$0.66

These costs were based on a given wage scale, but in all other tables the costs are reckoned in minutes because of fluctuations in wage scales.

Falling: Field data for each of the above mentioned operations were obtained by means of a stop watch and were segregated according to the various details of performing one operation. Thus, under "falling" we have the exact time taken up by "walking from tree to tree," "swamping," "planning," "undercutting," "barking," "preparing to saw," "wedging," "gathering tools," etc. The time of falling 113 trees is divided in Table II as follows: Resting 26.05 per cent, undercutting (saw and axe) 21.19 per cent, sawing 16.90 per cent, barking and swamping 10.87 per cent, planning 5.33 per cent, delays 5.25 per cent, wedging 4.68 per cent, preparing to saw 4.34 per cent, walking, tool fitting, etc., 5.39 per cent. All of these items are of course not affected by tree size. Finally, based on tree diameter, the author's analysis indicates that falling requires 77.5 minutes per M b. m. for an 18-inch tree as contrasted to but 19.1 minutes for a 48-inch tree.

Marking: From the standpoint of cost this operation is not important, but we find it strongly influenced by tree diameter, thus for an 18-inch tree marking requires 19.7 minutes, while for a 48-inch tree only 3.6 minutes are consumed, per M b. m.

Limbing: Observations on 125 trees cut indicate that 46.97 per cent of the time of limbers is consumed in actual chopping, 33.58 per cent in waiting for fallers, 14.72 per cent in resting, and 4.73 per cent in walking, preparation, etc. As affected by tree diameter we find that the limbing of medium-sized trees is more expensive than of either very small or very large ones, thus, 18-inch trees were limbed in 8.7 minutes per M b. m., 24-inch trees in 12.2 minutes, 36-inch trees in 17.0 minutes, and beyond this diameter the time gradually falls to 13.1 minutes for 48-inch trees. This the author explains by the fact that on the small trees the limbs, while numerous, are light and easily removed, while on the large trees they are concentrated above the merchantable portion of the trunk.

Bucking: This is the most important of the operations of log making from the standpoint of cost. At the camps where this operation was studied the trees are bucked by hand into long lengths in the woods, and then into shorter lengths at the landing by a steam saw. For 346 cuts made by hand it was found that only 35.68 per cent of the time was actually utilized for sawing, 17.60 per cent for resting, 12.40 per cent for bucking, 12.17 per cent "walking in and out," and the rest for eighteen other minor operations. Based on diameter of cut, we find that it took 407 minutes per M b. m. (16-foot logs) for a cut 8 inches inside the bark, 87.6 minutes for a cut 18 inches inside the bark, and 39.4 minutes for one of 56 inches. Steam bucking shows up better of course, but even here without the difference between individual men entering seriously we find that in making 233 cuts with the steam saw 61.47 per cent of the time was consumed in "waiting for the swing donkey" and only 19.19 per cent in actual sawing, although the time of waiting is not strictly affected by size of log. Combining the two methods of bucking, it is found that 18-inch trees required 54.2 minutes per M b. m. for the hand bucking and 22.2 minutes for the final bucking at the chute, or a total of 76.4 minutes; 48-inch trees required 21.1 minutes in the woods and 6.2 minutes at the chute, a total of 27.3 minutes.

Logging engineers should find a careful study of this bulletin of great value in suggesting means they might follow to apply the results reported or to make similar or more extended studies on their operations.

EMANUEL FRITZ.

Code for the Collection and Tabulation of Statistical Data. By S. H. Howard, B. A., Imperial Silviculturalist, British Indian Forest Service.

"This note, which gives the outlines of the system of collecting and tabulating statistical data, incorporates the various methods advocated by the Silvicultural Conference held at Dehra Dun in 1918 and any actual rules given, e. g., rules for permanent sample plots, are those advocated and approved by these two bodies."

It is interesting to note in the title the recognition given to mensuration as a branch of statistics rather than a mathematical science. It is believed that more consideration should be given to this fact in this country and the more advanced statistical methods applied in forestry.

The publication gives in detail the procedure to be followed, both in the field and office, in the measurement of permanent sample plots,

temporary sample plots, stem analysis, stump analysis, measurement of volumes and form factors of typical trees, bark and heartwood measurements, the collection of data to express the relation between lumber in the tree and converted, data concerning the existing growing stock per acre. The text is supplemented by appendices, under separate cover, giving sample plot forms and actual examples of the methods prescribed. These include maps, tables, growth and volume curves, etc.

The methods are essentially those of European practice, reference being made to Schlich, Volume III, and in addition the procedure to be employed with trees lacking growth rings.

It is also of interest that the use of calipers is prescribed to the exclusion of tape measurements.

The standardizing of the methods of collecting and tabulating data in this way is an excellent practice and is worthy of the attention of not only those interests in this phase of forestry, but foresters in general. This procedure permits of ready comparison and combination of data secured at different dates, the advantages of which are only fully realized by those who have attempted such with data collected by different methods.

R. M. B.

PERIODICAL LITERATURE

FOREST GEOGRAPHY AND DESCRIPTION

Forests of South Eastern Labrador

There is sharp contrast between the desolate treeless shore strip, due to year-round presence of ice in adjacent waters, and the heavily forested interior. The seaward edge of the forests consists of stunted and dwarfed black spruce (*P. mariana*), but the timber increases in height as one goes inland, to an average of 50-60 feet. Much of the timber is large enough for lumber production, but the bulk is more suitable for pulpwood. Exploitation has as yet just begun. Data are given on individual large trees. S. B. S.

Kindle, E. M. *Notes on the forests of southeastern Labrador.* Geog. Rev., 12: 57-71. 1922.

Forests of Dominican Republic

Fully three-fourths of the 19,000 square miles of the area of the republic can be classed as timberland. The island is rough and rugged with four principal mountain ranges, the highest of which attains elevations of over 8,000 feet. Rainfall is heavy (60″ + per year) and is well distributed. The forests are generally tropical in character and except for a few of the most valuable species, are little known. A generalized type map recognizes the following principal cover types: 1. Evergreen hardwood; 2. Partly evergreen hardwood; 3. Pine; 4. Thorn; 5. Savanna; 6. Mostly deciduous; 7. Littoral hardwood. Much of the exploitation has been in the partly evergreen hardwood type, and especially in the pine type. The general characters of each type are described. The pernicious practice of "comico making" or clearing of forest for temporary agricultural use, which has been so important a factor in destruction of forests elsewhere, is of considerable importance in the republic. A partial list of the trees of the island is included. S. B. S.

Durland, William Davies. *The forests of the Dominican Republic.* Geog. Rev. 12: 206-222. 1922.

Forestry Sketches in Portugal

In the spring of 1922 Dr. H. Knuchel, Forstmeister, at Shaffhausen spent approximately a month in Portugal investigating the forest conditions there. According to the latest statistics the land area is divided as follows: Tilled vineyards, and orchards, 35 per cent; forest, 22 per cent; waste, 43 per cent. The forest area is divided as follows: Maritime and stone pines, 48 per cent; evergreen oak, 22 per cent; cork oak, 20 per cent; chestnut, 5 per cent; deciduous oak, 4 per cent. The total forest area was 1,621,000 hectares in 1913. This area is increasing annually, especially that devoted to the production of naval stores. For the increase the activities of the Forestry Association and the pressure of economic conditions are responsible.

According to the laws of 1901 and 1903 the forest area is divided into protective forests and other forested areas. In the former are included all the State and some private forests. These are naturally administered more strictly than the other forest areas since they are necessary for the prevention of shifting sands and excessive erosion. All the receipts from the State forest areas are available for improvements. Salaries are, however, met from a separate fund. Considerable research, educational, and extension work has already been done. Six hundred hectares are planted annually in addition to road building, to open up the more inaccessible stands. In general Dr. Knuchel feels that the Forest Service is in good condition with excellent esprit de corps. The State forests amounted to over 87,000 acres in 1907.

In addition to this general statement in regard to the Portuguese Forest Service, Dr. Knuchel reports special visits to the planting work in the Serra da Estrella intended to prevent erosion in this mountainous region and the sand dune work along the coast. This latter is carried on in accordance with the methods developed by the French in the Landes. It takes approximately 10 years to build the shore dune to a height of six feet by means of a board fence. Fire control is secured by lookout towers and net work of fire lanes in this sandy region. K. W. W.

Schweizerische Zeitschrift für Forstwesen, Feb., Mar. and Apr., 1922.

SOIL, WATER, AND CLIMATE

The Evolution of Climate

A critical review in which are summarized the conclusions regarding the chronology of climatic phases since the last great glaciation of 30,000-18,000 B. C. The changes in vegetational types corresponding to the climatic changes are noted. The great importance

attached to changes in level of the land as a major factor of climatic variation by Brooks is questioned by the reviewer. The relation of changes in climate found in northwest Europe to those determined elsewhere by other investigators is discussed. S. B. S.

Huntington, Ellsworth. *The evolution of climate in northwestern Europe.* [Review of: Brooks, C. E. P. *The evolution of climate in northwestern Europe.* Quart. Journn. Royal Meteorol. Soc., 47: 173-194.] Geog. Rev., 12: 126-139. 1922.

Vegetation Map of Venezuela

A critical review in which are noted changes in relative proportion of woodland and agricultural land from previous estimates; the characteristics of the four principal forest types—dry woodlands, monsoon forests, tropical rain forests, and temperate forests—and of the llanos. S. B. S.

Anonymous. *A vegetation map of Venezuela.* [Review of: Pittier, Henri. *Mapa ecologico de Venezuela que demuestra las zonas naturales, los cultivos, las vios de communicacion y los principales centros mineros, etc.,* and accompanying text (Esboga de las formaciones vegetales de Venezuela con un breve reseñia de los productos naturales y agricolas), Caracas, 1920. Geog. Rev., 12: 300-302. 1922.]

Streamflow Experiment at Wagon Wheel Gap, Colorado [1]

In 1910, the Forest Service in cooperation with the Weather Bureau, initiated a streamflow experiment at the Wagon Wheel Gap Experiment Station. The purpose of the experiment was to secure reliable quantitative data on the effects of forest cover on runoff, with a view toward settling this much discussed question. Two drainage areas of approximately 200 acres each and as nearly alike as it was possible to secure them were selected for the study. The plan of the experiment was to keep continuous records of runoff and silting on the two areas over a sufficiently long period to establish a definite relationship, then denude one area and continue the records long enough to determine the effect of denudation. The first half of the program has been carried out. After about a year of preliminary work, installing meteorological instruments, weirs, settling basins, and other equipment, records were started in 1911 and are being maintained at the present time. One of the drainage areas, designated as Area B, was cleared of trees and slash in 1920.

[1] Bates, Carlos G. and Alfred J. Henry, Monthly Weather Review, Supplement No. 17, pp. 1-55, fig. 1-41. 1922.

The present preliminary report presents the results of the study prior to denuding watershed B. It contains detailed topographic and cover maps of the two areas and special reports on the geology and climate. Meteorological data, topography, soil, forest cover, and other factors are closely analyzed with reference to effect on runoff. Altogether, it would seem that every detail has been considered which might in any way affect the experiment. Since only the first phase of the study has been completed no conclusions as to the effect of the forest cover are presented. This is the most exhaustive experiment of its kind ever undertaken in this country, if not in the entire world.

Foresters are familiar with a similar experiment conducted by Engler [2] at the Swiss Experiment Station. This experiment ran from 1900 to about 1918. The investigation brings out many interesting facts some of which are contrary to prevailing notions, but in general supporting the belief among foresters that forest cover stabilizes streamflow and reduces erosion. Because of the difference in conditions, it is not safe to assume that the outcome of the two experiments will be the same in all particulars. What seems to be a weak point in the Swiss experiment is that the two watersheds were not similarly forested to begin with, one being described as wholly and the other partially forested, thus lacking the control feature provided in the Wagon Wheel Gap Experiment.

[2] Engler, Arnold, Untersuchungen uber den Einfluss des Waldes auf den Stand der Gewasser. Mitteil, der Schweitz. Zentralanst. fur das forstliche Versuchswesen, Zurich, 1919. Review by Zon in JOURNAL OF FORESTRY, October, 1920 (pp. 625-633).

STATISTICS AND HISTORY

Forestry Commission for New South Wales

During the year 1,096 acres were planted at a direct cost of £3,160, and an additional 1,705 acres prepared for planting. Substantial progress was also made in marking boundaries of State forests, constructing roads and fire breaks, and permanent improvements necessary for administrative purposes. The area of forest under systematic fire protection is 759,000 acres out of a total of 5,194,000 of State forests, plus 1,536,000 acres of timber reserves. The wet season helped in keeping fire losses to a very low figure. During the year 140,944 acres were

put under working plans, bringing the total to date up to 875,037. 36,000 acres of natural forest were treated for regeneration. The gross revenue was £190,742, the administrative expense £57,835, and expenditure on forest works £104,782. The value of timber imported was £2,073,046, and of exported £464,725. Detailed data on all activities and costs are given in a comprehensive series of tables. The total production of native timber was 155,114 M sup. feet, and total consumption 352,882 M. Progress has been made in botanical studies, in securing data on valuable exotics for introduction, and on use of certain woods for pulp. A valueable feature of the report is the graphic summary of the principal data. S. B. S.

Dalrymple—Hay, R. *Report of the Forestry Commission for New South Wales for the year ending June 30, 1921.* pp. 18. Sydney, N. S. W. 1921.

Report of H. M. Woods, Forests and Land Revenues

The total income for the year was £1,234,645, of which £100,494 was from timber, the balance from agricultural and house property, mines, interest, etc. The expenditures were £549,314, of which £68,365 was for planting and preparation of timber for sale. In accordance with various acts of Parliament, expenditures, incomes, leases, rents, etc., are given in great detail. There is no information of consequence on progress of forestry: the report simply gives business details. S. B. S.

Griffith—Boscawen, Arthur and G. G. Leveson Gower. *The ninety-ninth report of the commissioners of H. M. woods, forests, and land revenues for the year ending March 31, 1921.*

New Zealand Forest Service Report

The year is characterized as one of stock-taking, of study of conditions and problems, and the creation of the Forest Service for administration of forests and woodlands, which now total 6,800,000 acres. Seven forest conservation regions have been established. The policy contemplates scientific management, systematic protection, planting on all Crown forest lands, establishment of a forest school, and promotion of research. The Forest Service at present has a force of 97. General reconnaissance of several of the principal mountain ranges was made. Receipts and expenditures are given in detail, and general summary from 1896 to date showing total revenue at £32,040 per year against £23,570 expense. A total of 2,500,-

000 acres of timberland has been destroyed by fire, and this loss continues at the rate of 50,000 acres a year. A total of 38,461 acres has been planted since 1896. Research on some of the major problems has been started in energetic fashion. Total production of lumber for the year was 309,162 M superficial feet. It is urgently recommended that all available Crown forest land be dedicated as provisional State forest. Detailed summaries of the afforestation work shows special measures taken to protect plantations from fire, that 520,000 trees were planted by ranchers, etc., during the year, while 2,877,000 were planted on State forests on 1,381 acres. Data on export and import of timber are given.

S. B. S.

Ellis, L. MacIntosh, New Zealand Forest Service. *Report for the year ending March 31, 1921.* pp. 20. Wellington, N. Z. 1921.

Oaks of Troncais

The oak forest of Troncais is one of the most famous hardwood stands in France. The English forest school students make a point of visiting it annually. It is located about fifty kilometers west of Moulin on relatively level topography. As a consequence the roads are straight and divide the forest area up into compartments of geometrical form.

As early as 1645 the oak timber from this area was famous. In 1670 Colbert made regulations to insure a continuous supply of ship timber from this area. The rotation at that time was roughly 200 years. During the period from 1750 to 1835 the forest was badly over-cut for charcoal to supply the nearby iron mines. At the present time the effects of this over cutting are still evident and it will be nearly sixty years before the stand is normal in its stocking. The present rotation ranges from 144 to 180 years and the stand is cut up into six cutting series of 24 to 30 years each. At the present time there are 10,438 hectares devoted to the production of high grade oak timber.

The problem of regenerating the oak is a difficult one on account of the necessity of preserving an understory of beech and hornbeam. The purpose of this understory is to force the oak trees to grow straight and tall and protect the soil from weed growth and drying out. Complete regeneration takes a full cutting cycle of 30 years and precedes

in a series of gradual steps. It is, of course, necessary to remove the understory first and the purchasers of stumpage are required not only to cut the beech and hornbeam but also grub out the stumps and roots where that is considered necessary to secure the regeneration of oak. Good seed years of the latter only occur at periods of seven to eight years. Ordinarily there is little damage from frost and the area which needs to be planted up is comparatively small. Where this is necessary, however, nursery grown stock two years old which has been root pruned is used. The acorns are sown in the nursery in the fall.

From the beginning it is necessary to prevent the secondary species from overtopping and crowding out the oak so that some thinning is done even before merchantable material can be secured. The thinning in the main stand of oak is almost entirely par-le-bas. In this way the poorer individuals are taken out. Thinning in the understory on the other hand is par-le-haut. By this method high production per acre of the tolerant beech and hornbeam is secured.

In accordance with the usual practice in France national forests sales of material are entirely on the stump. As stated above, the purchaser is required not only to cut the timber in such a way that little damage will be done but also must prepare the ground for regeneration where that is desired. The purchasers of this high grade oak dispose of most of the wood for making cognac barrels. A small percentage is sold for veneers.

K. W. W.

Der Eichenwald von Troncais. Schweizerische Zeitschrift für Forstwesen. June, 1922.

CURRENT LITERATURE

Compiled by Helen E. Stockbridge, Librarian, U. S. Forest Service

LIST FOR OCTOBER, 1922

(Books and periodical articles indexed in library of U. S. Forest Service)

Forestry as a Whole

Illick, J. S. Guide to forestry: book one. 83 p. illus., map. Harrisburg, 1922. (Pennsylvania—Dept. of forestry. Bulletin 26.)

Reports and proceedings of associations, forest officers, etc.

Australian forestry conference. Report of proceedings of the Australian forestry conference, Brisbane, April, 1922. 142 p. Brisbane, Govt. printer, 1922.

Connecticut forestry association. Proceedings, 1921-22. 39 p. New Haven, Conn., 1922.

Florence—Istituto superiore forestale nazionale. Atti del 1.Convegno tecnico-forestale Italiano. 306 p. illus. Firenze, 1922. (Publication no. 7.)

India—Baluchistan—Forest dept. Progress report of forest administration for 1920-21. 24 p. Calcutta, 1922.

India—Bombay—Forest dept Report of the forest administration for the year 1920-21. 130 p. Bombay, 1922.

India—Punjab—Forest dept. Progress reports of forest administration for the year 1920-21. 81 p. Lahore, 1921.

Louisiana—Dept. of conservation—Division of forestry. Report, 1920-1922. 23 p. New Orleans, La., 1922.

New Zealand—State forest service. Report for the year ended 31st March, 1922. 25 p. illus. Wellington, 1922.

Philippine Islands—Bureau of forestry. Annual report for the fiscal year ended Dec. 31, 1921. 103 p. diagr. Manila, 1922.

Société dendrologique de France. Bulletin no. 44. 44 p. Paris, 1922.

Society of American foresters. Constitution and members of the Society. 29 p. Wash., D. C., 1922.

Forest Aesthetics

Trelease, W. Plant materials of decorative gardening: the woody plants. 2d ed., rev. 177 p. Urbana, Ill., Pub. by the author, 1921.

Forest Education

Forest schools

North Dakota—Forestry state normal school. 16th annual catalog number, 1921-1922. 86 p. pl. Bottineau, S. Dak., 1922.

University of Michigan—College of literature, science and the arts. Announcement of the curriculum in forestry, 1922-1923. 48 p. Ann Arbor, 1922.

Forest Description

Waterman, W. G. Forests and dunes from Point Betsie to Sleeping Bear, Benzie and Leelanau counties, Mich. 20 p. illus. Evanston, Ill., Northwestern university, 1922.

Wildeman, Emile de. Mission forestière et agricole du Comte Jacques de Briey, ingénieur agronome. au Mayumbe (Congo Belge). 468 p. illus., pl. Bruxelles, D. Reynaert, 1920.

Forest Botany

Brown, H. P. Trees of New York state, native and naturalized. 401 p. illus., map. Syracuse, 1921. (New York state college of forestry, Syracuse university. Technical publication no. 15.)

Conzatti, C. Monografia del arbol de Santa Maria del Tule. 65 p. illus. Mexico, Talleres graficos de la nacion, 1921.

Wilson, E. H. The romance of our trees. 278 p. pl. Garden City, N. Y., Doubleday, Page and co., 1920.

Silvical Studies of Species

Mattoon, W. R. Longleaf pine. 50 p. illus., pl. Wash., D. C., 1922. (U. S.—Dept. of agriculture. Bulletin 1061.)

Vadas, E. Die monographie der robinie, mit besonderer rücksicht auf ihre forstwirtschaftliche bedeutung. 252 p. illus., pl., diagrs. Selmecbánya, A. Joerges & sohn, 1914.

Wildeman, E. de. Les bambous en Afrique. 36 p. Bruxelles, Goemaere, Imprimeur du Roi, 1921.

Silviculture

Planting and nursery practice

Argentine Republic—Dirección general de agricultura y defensa agricola. Informe sobre las dunas y plantaciones de Chile, presentado por Pedro A. Bovet. 112 p. illus., maps. Buenos Aires, 1913.

Virginia—State forester. Plant-stock available from the state forest nursery at the University of Virginia, Charlottesville, in the autumn of 1921 and the spring of 1922. 13 p. Charlottesville, 1921. (Bulletin no. 23.)

Forest Protection

Insects

Waterston, J. On chalcidoidae (mainly bred at Dehra Dun, U. P., from pests of sal, toon, chir and sundri.) 44 p. illus. Calcutta, Supt. govt. printing, 1922. (Indian forest records, vol. 9, pt. 2.)

Animals

Institute of civil engineers—Committee appointed to investigate the deterioration of structures of timber, metal and concrete exposed to the action of sea-water. Second (interim) report. 56 p. illus. London, 1922.

Fire

New Hampshire—Forestry commission. Forest fire manual and personnel of the forest fire service 98 p. Concord, 1922.

Texas—Office of the State forester. Manual of instruction for Texas state patrolmen. 258 p. illus. College Station, Tex., 1922.

Forest Management

Deam, C. C. Indiana woodlands and their management. 20 p. pl. Indianapolis, 1922. (Indiana—Dept. of conservation. Publication 28.)

Forest Legislation

France. Laws, statutes, etc. Code forestier, suivi des lois sur la pêche et la chasse, et code rural. 17th ed. 279 p. Paris, Librarie Dalloz, 1922.

Peyton, J. S. State forestry laws of 1921. 28 p. Wash., D. C., 1922. (U. S.—Dept. of agriculture. Department circular 239.)

Forest Economics

Forest policy

Wisconsin—State conservation commission. Timber for the state. 8 p. illus. Madison, 1922. (Bulletin 5.)

Forest statistics

Fjelstad, A. Memoir concerning the organisation of world stastistics on sylviculture, also on allied industry and commerce. 9 p. Rome, International institute of agriculture, 1921.

Forest Utilization

Brush, W. D. Utilization of basswood. 64 p. illus., pl. Wash., D. C., 1922. (U. S.—Dept. of agriculture. Bulletin 1007.)

Lumber industry

Oakleaf, H. B. Lumber manufacture in the Douglas fir region. 182 p. illus. Chicago, Commercial journal co., 1920.

Southern pine association. Official report of the seventh annual meeting, Mar. 28-9, 1922. 264 p. New Orleans, 1922.

Wood-using industries

Lincke, M. Das grubenholz von der erziehung bis zum verbrauch. 422 p. illus., tables. Berlin, P. Parey, 1921.

United States—14th Census. Manufactures, 1919: Forest products. 84 p. Wash., D. C., 1922.

Forest by-products

Simonsen, J. L. The essential oil from the leaves of Abies pindrow, Spach. 5 p. Calcutta, Supt. govt. printing, 1922. (Indian forest records, vol. 8, pt. 5.)

Wood Technology

Gamble, J. S. A manual of Indian timbers; reprint of 2d edition, with some additions and corrections. 868 p. pl., map. London, Sampson Low, Marston & co., ltd., 1922.

London—Institute of brewing—Research fund committee. Timber investigations. 52 p. London, 1922.

Wood Preservation

Bateman, E. Coal-tar and water-gas tar creosotes: their properties and methods of testing. 114 p. illus., diagrs., tables. Wash., D. C., 1922. U. S.—Dept. of agriculture. Bulletin 1036.)

Pearson, R. S. Results of antiseptic treatment of sleepers. 49 p. pl., diagrs. Calcutta, Supt. govt. printing, 1922. (Indian forest records, vol. 9, pt. 1.)

Auxiliary Subjects

Conservation of natural resources

Louisiana—Dept. of conservation. Fifth biennial report. 1920-1921. 102 p. New Orleans, La., 1922.

Description and travel

Bell, P. L. Venezuela: a commercial and industrial handbook, with a chapter on the Dutch West Indies. 472 p. pl., maps. Wash., D. C., 1922. (U. S.—Dept. of commerce—Bureau of foreign and domestic commerce. Special agents series, no. 212.)

Campbell, M. R. Guidebook of the western United States, pt. E: The Denver and Rio Grande western route. illus., pl., maps. Wash., D. C., 1922. (U. S.—Geological survey. Bulletin 707.)

Williams, M. B. Through the heart of the Rockies and Selkirks, Canada's national parks. 105 p. illus., maps. Ottawa, Canada, Dept. of the interior, 1921.

Periodical Articles

Miscellaneous periodicals

American city, Sept., 1922—Insuring satisfaction in tree planting, p. 243-6.

American city, Oct., 1922—Problems in the reforestation of watersheds, by G. R. Taylor, p. 347-9.

Aviation, Sept. 4, 1922—Forest fire patrol by airplane and radio, by S. R. Winters, p. 282-3.

Beihefte zum Botanischen centralblatt, Aug. 5, 1922—Ueber die abscheidung von harzbalsam auf den jungen trieben unserer einheimischen Populus-arten, by D. Feher, p. 81-103.

Bulletin of the Pan American union, Nov., 1922—Certain trees of Brazil: their economic and industrial uses, by C. R. Cameron, p. 486-92.

Bulletin of the Torrey botanical club, Sept. 1922—New species of trees of medical interest from Bolivia, by H. H. Rusby, p. 259-64; Notes on trees and shrubs of the southeastern United States: Castanea pumila group, by W. W. Ashe, p. 265-8.

Bulletin of the Torrey botanical club, Oct., 1922—Quercus lyrata in Iowa, by B. Shimek, p. 293-5.

Chemical and metallurgical engineering, Sept. 13, 1922—The artificial silk industry, by H. Schlatter, p. 533-7.

Chemical and metallurgical engineering, Oct. 11, 1922—Variety of chemical by-products tried as wood preservatives, p. 736.

Chemical and metallurgical engineering, Oct. 18, 1922—Modern practice in manufacture and applications of steamed ground wood, by A. O. Bragg, p. 842-6.

Country gentleman, Sept. 30, 1922—Settling the east: its empire of idle acres is increasing, by P. S. Lovejoy, p. 1-2, 16.

Garden magazine, July, 1922—The autograph of an ash tree, by D. T. MacDougal, p. 313-15.

Garden magazine, Sept. 1922—The moving of trees and shrubs, by J. L. Doan, p. 14-16.

Geographical review, Oct., 1922—Some unusual erosion features in the loess of China, by M. L. Fuller, p. 570-84.

House and garden, Aug., 1922—Operating on trees, by J. Davey, p. 52-3, 86.

House and garden, Sept., 1922—Our American birches, by H. S. Ortloff, p. 56-7, 82.

Illustrated world, Sept., 1922—How the timber sleuths track firebugs, by D. G. Hobson, p. 75-6.

Journal of industrial and engineering chemistry, Oct., 1922—The chemistry of wood: 4. The analysis of the wood of Eucalyptus and Pinus monticola, by S. A. Mahood and D. E. Cable, p. 933-4; The calorific value of American woods, by S. W. Parr and C. N. Davidson, p. 935-6; Ethyl alcohol from western larch, Larix occidentalis, Nuttall, by E. C. Sherrard, p. 948-9.

Journal of the Dept. of agriculture of South Africa, Sept., 1922—Apparent infertility of the soil around trees, by C. O. Williams, p. 254-8.

Missouri botanical garden bulletin, Sept., 1922—The giant cactus, p. 117-18.

Nature study review, Oct., 1922—The pine, by H. Klein, p. 284-92.

New Zealand journal of science and technology, July, 1922—The kauri forest, by T. F. Cheeseman, p. 166-8.

Oregon teachers monthly, Sept., 1922—Teaching of forest fire prevention, by J. D. Guthrie, p. 1-2.

Outlook, Nov. 1, 1922—Gifford Pinchot, by E. J. Hunter, p. 378-80.

Parks and recreation, Sept.-Oct., 1922—National existence and rural recreation, by A. H. Carhart, p. 15-17; Care of park trees, by W. C. Holsworth, p. 28-31.

Phytopathology, Sept., 1922—Observations on two poplar cankers in Ontario, by E. H. Moss, p. 425-7.

Popular mechanics, Oct., 1922—Speed kiln-drying process and improve lumber, in France, p. 548; Playground for the people in national forest, p. 586-8.

Rhodora, May, 1922—Notes on trees and shrubs of southeastern North America, by W. W. Ashe, p. 77-9.

Saint Nicholas, Oct., 1922—Trapped by the red terror, by W. I. Hutchinson, p. 1292-5; The cone gatherers, by E. C. Brill, p. 1308-12.

Science, Sept. 29, 1922—Effects of forest fires on food and game fishes, p. 362.

Sunset, Nov., 1922—A girl expert in forestry, by E. Heiner, p. 31.

Torreya, Sept.-Oct., 1922—Notes on a growth of young white pine, by H. C. Wickenheiser, p. 84-6.

Trade journals and commerce reports

American lumberman, Sept. 30, 1922—What color is pine, by H. S. Betts and W. D. Brush, p. 50-2; Finding solution of forest taxation, by F. R. Fairchild, p. 54-5.

American lumberman, Oct. 14, 1922—Laboratory studies wood turning industry, p. 70.

American lumberman, Oct. 21, 1922—Central committee on lumber standards issues statement on the progress made, p. 43-5; The influence of the national forests upon the lives of our people, p. 49; Maine forestry in prospect and retrospect, by A. Cary, p. 65-6; Many state laws in aid of forestry, by L. S. Murphy, p. 51; Discuss uses for Maine hardwoods, p. 52.

American lumberman, Oct. 28, 1922—A "billet" mill for manufacturing small logs, p. 1, 53.

Autobody, July, 1922—Construction and finish of plywood bodies, by A. Elmendorf, p. 219-21.

Canada lumberman, Sept. 15, 1922—Forest fire menace may be regulated by legislation and other means, by W. F. V. Atkinson, p. 117-18; Where lumbermen may learn everything about the wood they cut, by A. F. Roberts, p. 119; Jack Pine: its use, growth and adaptability, by R. D. Craig, p. 120-1; What Nova Scotia is doing in the lumber manufacturing line, by C. McKay, p. 122-4; How lumber stackers save space and labor in the mill yard, p. 125-6; New Brunswick faces tremendous losses from the spruce budworm, by L. S. Webb, p. 134-5; Poplar can be used for many purposes, by A. C. Weight, p. 140-1; Many uses for the aeroplane in woods work, by E. Wilson and S. Moir, p. 143, 166; How to eliminate loss in piling of lumber, p. 147-8; A lumber yard without lumber, by R. Black, p. 156-8; How the Forest products laboratories can serve the wood-user, by W. B. Stokes, p. 138.

Canada lumberman, Oct. 1, 1922—Making railway ties—the bed of the nation, by A. C. Weight, p. 37-8.

Canada lumberman, Oct. 15, 1922—Awful sweep of forest fires in new Ontario, p. 39; Revolving machine for air drying lumber, p. 47.

Canning age, Sept., 1922—The wirebound box, by D. L. Quinn, p. 27-34, 41.

Commerce monthly, Oct., 1922—The lac trade, p. 13-15.

Cross tie bulletin, June-Aug., 1922—Why the creosoted tie, by P. R. Hicks, p. 11-15.

Disston crucible, Sept., 1922—The sentinel elm, p. 57, 63.

Engineering news-record, Oct. 12, 1922—Greenheart as teredo resistant on Panama locks, by G. J. Embree, p. 619-21.

Engineering news-record, Nov. 2, 1922—Gunite applied to fir piles for Tacoma pier, p. 739-41.

Fibre containers, Sept., 1922—Analysis of the construction of an ideal shipping container, by A. Elmendorf and J. R. Watkins, p. 10-14.

Hardwood record, Oct. 10, 1922—Standardization committee formulates creed, p. 17-18, 20.

Hardwood record, Oct. 25, 1922—On importance of drying lumber free from stresses and strains, by J. F. Hirt, p. 28-9; The utilization of blue stained wood, by E. E. Hubert, p. 32.

Lumber, Sept. 1, 1922—Four-L offers solution of industrial problem, by H. P. Edward, p. 7-8; The woods of commerce: mahogany in peninsular Florida, by C. D. Mell, p. 11.

Lumber, Sept. 22, 1922—Western pine tract open for development, by W. B. Greeley, p. 9-10.

Lumber, Sept. 29, 1922—The woods of commerce: the use of cabbage palmetto, by C. D. Mell, p. 10.

Lumber, Oct. 13, 1922—The woods of commerce: the cottonwoods, by C. D. Mell, p. 8, 10.

Lumber, Oct. 27, 1922—The woods of commerce: the Kentucky coffee tree, by C. D. Mell, p. 9.

Lumber and veneer consumer, Sept. 30, 1922—The characteristics and uses of oak, p. 15-17; Manufacture of modern hardwood flooring, p. 18-21.

Lumber trade journal, Oct. 15, 1922—Great southern lumber company closes contract for reforestation of 53,000 acres of cut-over land, by V. H. Sonderegger, p. 25.

Lumber world review, Sept. 25, 1922—How the national forests are managed and operated: logging national forest timber in the White mountains, by J. J. Fritz, p. 27-9.

Lumber world review, Oct. 10, 1922—Commemoration tablet at Fernow Hall unveiled, by R. S. Hosmer, p. 31.

Lumber world review, Oct. 25, 1922—The Roberts experimental plant at Urania and what it means to the south, by Pearl McCartney, p. 31-2; Appalachian forest experiment station's investigative program, p. 32.

Manufacturers record, Aug. 31, 1922—Wood preservation: its purpose, development, and industrial importance, by P. R. Hicks, p. 51-4.

Paper, Aug. 16, 1922—Manufacture of paper in China, by H. K. Richardson, p. 9-10, 17.

Paper mill and wood pulp news, Oct. 7, 1922—Paper: its past, present and future, by E. Beck, p. 14-16, 40; Reforestation: a paper mill problem, by S. T. Dana, p. 42.

Paper trade journal, Aug. 24, 1922—Vocational education in pulp and paper manufacture, p. 41-2.

Paper trade journal, Oct. 5, 1922—Mechanical extraction of moisture from bark, by G. D. Bearce and J. D. Rue, p. 49-50; Utilization of bark and wood refuse as fuel, by E. R. Schafer, p. 51-4.

Pulp and paper magazine, Aug. 31, 1922—Professional engineering in the B. C. logging industry, by T. W. Fairhurst, p. 752-3.

Savannah naval stores review, Sept. 23, 1922—A turpentine plan, by A. Cary, p. 6, 12.

Savannah naval stores review, Oct. 7, 1922—Mayor Capdupuy tells French fellow citizens about what he saw in this country, p. 10, 30.

Savannah naval stores review, Oct. 28, 1922—The wood tar industry as it is conducted in Finland, p. 10.

Southern lumber journal, Sept. 15, 1922—Treated timber for highway construction, p. 29-30; Logging now and then, p. 40, 53.

Southern lumber journal, Oct. 1, 1922—The destructive action of the marine borers, by H. von Schrenk, p. 28-9, 40.

Southern lumber journal, Oct. 15, 1922—The lumber standardization program and conservation, by S. F. D. Meffley, p. 16-17; Forestry in New Hampshire, by J. H. Foster, p. 23.

Southern lumberman, Sept. 23, 1922—Exhibit portrays value of forest protection, p. 34; Tests of the mechanical properties of native woods at the Forest products laboratory, Madison, Wis., p. 35.

Southern lumberman, Sept. 30, 1922—Rosin and lampblack vs. red lead and oil: their relative value as coatings to prevent end checking of stock during kiln drying, by J. D. Studley, p. 42-3.

Timber trades journal, Sept. 2, 1922—Renovating wood blocks, p. 626.

Timber trades journal, Sept. 9, 1922—The forests of the Empire, p. 739.

Timber trades journal, Sept. 16, 1922—Afforestation in the north, p. 759-60; Some timbers of Kenya colony, by H. A. Cox and H. Stone, p. XXIX-XXXI.

Timber trades journal, Sept. 23, 1922—Western larch as motor fuel, p. 847.

Timber trades journal, Sept. 30, 1922—Plywood for box work, p. 897; Fencing and insects, by A. M. Altson, p. 901.

Timber trades journal, Oct. 7, 1922—British forestry; the past 70 years, by C. E. Curtis, p. 1029-30.

Timberman, Sept., 1922—Humidity effect on Herman creek fire, by J. V. Hofmann, p. 34-5; How to obtain rigidity in crate construction, p. 75; Early days in the north woods, p. 124.

Timberman, Oct., 1922—Popular forestry (abstract of article in McCalls magazine for October), by C. E. Chambers, p. 27; A trip in the Ambasamudrum hill forests, south India, during the monsoon, by C. S. Martin, p. 33; New type sawmill, p. 44-5; Lumbering in the Philippine Islands, by W. G. Scrim, p. 48B; Japan's growing lumber trade, by K. Kume, p. 71; Aerial forest surveys in Canada, by D. R. Cameron, p. 78; Proposed federal forestry bill, p. 97; The pine white butterfly in southern Idaho, by H. C. Shellworth, p. 130-2; Lumber distribution on the Atlantic coast, by G. Quayle, p. 135, 139; Poland's forest resources, lumber industry and trade, by P. Le Tallec, p. 146-52.

U. S. commerce report, Oct. 9, 1922—Lumber industry of United Kingdom for August, by A. V. Dye, p. 81; Trieste, Italy, as a lumber center, by E. N. Atherton, p. 81-2; The Swedish lumber trade, by D. I. Murphy, p. 82; Belgian market for window frames and doors, by H. L. Smith, p. 82-3.

U. S. commerce report, Oct. 16, 1922—August exports of lumber and wood products, p. 133-4; Our foreign trade in box shooks, p. 134-7.

U. S. commerce report, Oct. 23, 1922—Wood-block paving in Tokyo, by H. A. Butts, p. 234.

U. S. commerce report, Oct. 30, 1922—British tests on Douglas fir, by A. V. Dye, p. 282-3; Lumber trade in Manchester, by R. E. Holaday, p. 283.

Veneers, Oct., 1922—Spanish cedar, the cigar-box wood, by F. Trotman, p. 25-6; The manufacture of good plywood, by P. C. Jurden, p. 34-6.

West Coast lumberman, Oct. 15, 1922—Forestry conference outlines taxation and forest policy programme for the state of Washington, p. 24-5, 28, 45; Our foreign trade in box shooks, by A. H. Oxholm, p. 26, 50; Protests sale of Forest service timber in the west, by C. S. Elms, p. 32.

Wood-worker, Oct., 1922—The question of speed in kiln-drying, by H. H. Addison, p. 45-6.

Forest journals

Allgemeine forst—und jagdzeitung, May, 1922—Zur dauerwaldfrage, by Hausrath, p. 99-107; Grossschlag, streifenschlag, saumschlag, by C. Wagner, p. 108-11.

Allgemeine forst—und jagdzeitung, June, 1922—Die ergänzung unvollkommener laubholzverjüngungen, by C. Wagner, p. 121-5; Natürliche verjüngung auf dem buntsandstein des Odenwaldes, by Kirchgessner, p. 125-7; Der wertmeter; eine forstliche rechnungseinheit, by Künkele, p. 127-9.

Allgemeine forst—und jagdzeitung, July, 1922—Die entwicklung der waldwirtschaft in den gemeindewaldungen des oberen Kinzigtales, by F. Bauer, p. 145-58.

American forestry, Oct., 1922—West Persia, the wood famine country, by E. C. M. Richards, p. 579-85; The white oaks, by J. S. Illick, p. 586-92; State foresters in Minnesota, by O. M. Butler, p. 593-7, 606-7; Publicity in state forestry work, by H. C. Campbell, p. 603-6; The move to standardize lumber, p. 607-8; National forests and surplus military reservations, p. 608; Twin trees and natural grafts, by E. F. Andrews, p. 609-11; The future of the American lumber supply, by A. B. Recknagel, p. 611-12; Growth of sound ideas in game management, by W. Shepard, p. 613-16; A ship's knees, p. 623; Spreading the forestry idea, by P. W. Ayres, p. 624-5; Forest insects in the northeast, by H. B. Peirson, p. 628-34.

Australian forestry journal, July, 1922—The significance of forests, by C. E. Lane-Poole, p. 180-1; Diseases of Pinus insignis, by W. A. Birmingham, p. 181-2; Forest cover on mountain and plain, by A. D. Hardy, p. 183-7; Notes on forest pathology from South Australia, by G. Samuel, p. 189-92; The troubles of a forest guard, p. 192-3; Boot soles from ti-tree, p. 197; What the Chinese do with sandalwood, p. 199-200.

Australian forestry journal, Aug., 1922—The West Australian red gum (marri kino), p. 203-6; The Empire's timber, by H. D. Searles-Wood, p. 211-12; The Royal commission on forestry, p. 213-15; Training boys for forest work, p. 215-17; Marri for boat knees, p. 217; New tanning materials, p. 219-23; The carob and algaroba beans, p. 227-8.

Canadian forestry magazine, Sept., 1922—Planting memorial trees on roadways, by H. J. Moore, p. 995-6, 1049-50; High trees, not high tariff, is secret of trade, by C. D. Howe, p. 997-8; James Oliver Curwood, a champion of woods and wild life, p. 1000-1; Home making by tree planting, by D. Howes, p. 1002-3; Mountaineering in the Canadian Rockies, by L. Stewart, p. 1004-6; Athel windbreak, p. 1011; How wood is distilled and what results, p. 1011; Timber resources of Australia, by J. D. Macfarlane, p. 1015, 1048; Les forêts du Portugal, by N. Le Bressant, p. 1016-17; Prize essay in Barnjum contest, by P. Swanson, p. 1022-4; How Paris manages her shade trees, by W. Solotaroff, p. 1026; Handling a farm bush for profit, by J. A. Ferguson,

p. 1028; Controlling forest fires from the air, by E. Wilson, p. 1032; Wolman process for wood preserving, by G. W. R., p. 1039; Forest fires and radio, by C. Shannon, p. 1044.

Canadian forestry magazine, Oct., 1922—Improving protection of Ontario's forests, by A. V. Gilbert, p. 1065; How woodcraft is taught to boy scouts, by C. W. Thompson, p. 1066-7; Shelter belts on prairie farms, by J. C. Rutherford, p. 1068-70; Commercial forests for Canadian towns, by C. Leavitt, p. 1072-3; New Brunswick's forest losses low, p. 1074-5; How to plant trees in fall, by B. R. Morton, p. 1076-7; The railways and forest fires, by C. Leavitt, p. 1078-9; A plan to improve Ontario's forest management, by J. F. Clarke, p. 1080-1, 1109-12; Public opinion: the lumberman's senior partner, by R. Black, p. 1086-91; 1000 miles in a survey airplane, by A. M. Narraway, p. 1096-7; Forest research in eastern Canada, by T. W. Dwight, p. 1098-9.

Centralblatt für das gesamte forstwesen, Jan.-Feb., 1922—Erfahrungen mit Wagners blendersaum auf der Fürst Franz Liechtensteinschen herrschaft Neulengbach, by E. Beutl, p. 1-10; Ueber Anthonomus varians Payk., by H. E. Wichmann, p. 10-13; Die schwarzföhre am Triester Karst, by A. Cieslar, p. 13-32; Die wälder der standesherrschaft Schwarzenberg, by F. Heske, p. 32-45; Ueber forstliche bodenpflege, by E. Kreutzer, p. 45-50; Ueber den einfluss der anbaumethode auf den ertrag der fichte, by A. Cieslar, p. 60-9; Die Radstädter exotenversuchsfläche, by J. Rockberger, p. 75-83.

Empire forestry, Sept.-Dec., 1922—Westminster Hall; oak timber used in the roof, by Sir Frank Baines, p. 203-15; Timber depletion in the United States: a review of a report by the Forest service, by Sir John Stirling Maxwell, p. 216-28; The central forest research institute at Dehra Dun, India, by Sir George Hart, p. 247-52; Femelschlagbetrieb, a Swiss system of forest management, by R. M. Gorrie, p. 253-6; A note on the durability of Indian teak, by S. M. Edwardes, p. 257-60.

Forest leaves, Oct., 1922—Pennsylvania forestry, by R. Y. Stuart, p. 162-3; Purchase of forest lands in the eastern mountains as a means of warding off the approaching timber shortage, by P. W. Ayres, p. 164-5; A sketch in forest conditions, by F. Roth, p. 165-7; Red pine in the Sinnemahoning forest district, by C. Hogeland, p. 168-71; National forestry in Pennsylvania, by L. L. Bishop, p. 171-3.

Forstwissenschaftliches centralblatt, Aug.-Sept., 1922—Ueber die schattenfestigkeit der holzarten, by Schubert, p. 285-90; Beiträge zur forstlichen zuwachskunde, by Heck, p. 290-326; Neue und alte betriebsformen, by J. Eberhard, p. 326-42.

Hawaiian forester and agriculturist, Aug., 1922—Lands to be acquired in Molokai forest reserve, by C. S. Judd, p. 167-71.

Indian forester, Sept., 1922—In the land of the Monbas, by E. A. Smythies, p. 479-94; Cedrela serrata timber, by M. R. K. Jerram, p. 501-2; Pinus merkusii, by A. Rodger, p. 502-4.

Journal forestier suisse, Oct., 1922—Le Sirex et son parasite, by A. Barbey, p. 173-6; Les forêts de la commune de Ste-Croix, by H. Badoux, p. 176-8.

North woods, Sept., 1922—Forests in the Czechoslovak republic, p. 7-10.

North woods, Oct., 1922—General C. C. Andrews succumbs, p. 5-8.

Quarterly journal of forestry, July, 1922—The western larch in cultivation, by A. Henry, p. 161-74; British timber, by M. C. Duchesne, p. 175-98; The afforestation of Dartmoor, by W. J. Hale, p. 198-200; The experience of a divisional officer (timber supply department) during the war: review, by H. A. Pritchard, p. 202-6; Death duties on timber, by J. Vaughan, p. 212-16.

Revue des eaux et forêts, Aug., 1922—La cèdre au Mont-Ventoux et en Provence, by H. de Brun, p. 249-56; Une menace pour les forêts françaises, by L. Pardé, p. 257-8.

Schweizerische zeitschrift für forstwesen, Sept., 1922—Forsteinrichtungstechnisches, by P. Flury, p. 235-40.

Schweizerische zeitschrift für forstwesen, Oct., 1922—Aufforstungen auf dem Randen, by H. Grossmann, p. 257-9; Der einfluss der wälder auf den standort der industrien, by L. Weiss, p. 259-61; Bericht des ständigen komittees über die studienplanreform an der forstlichen abteilung der Eidg. technischen hochschule, p. 262-71.

Tharander forstliches jahrbuch, 1922—Rückblicke auf den stand der wichtigeren ereignisse, literarischen erscheinungen und fortschritte der forstlichen wissenschaft und praxis, by Jentsch, p. 141-61; Zur verständigung in sachen der waldrententheorie, by E. Ostwald, p. 162-91; Die abnahme der buche im Erzgebirge und Vogtland, by Martin, p. 191-6.

Yale forest school news, Oct., 1922—A word to the alumni of the Yale forest school, by H. S. Graves, p. 55-6.

Zeitschrift für forst—und jagdwesen, July, 1922—Altersbestimmung der riesenbäume, by Wilbrand, p. 385-9; Zur organisationsfrage der preussischen staatsforstverwaltung, by Lamberts, p. 389-93; Zur frage der rohhumusdüngung, by Swart, p. 393-401; Abnutzungskontrolle und abnutzungssatz, by Rave, p. 425-8; Dauerwald und betriebsart, by H. Roth, p. 428-9.

Zeitschrift für forst—und jagdwesen, Aug., 1922—Begründung von kiefernbeständen, by Greve, p. 449-68; Zur betriebsregelung und nutzungskontrolle in Preussen, by Merten, p. 469-78; Ueber ein neues, in der wirkung dem nikotin vermandtes insecticid "Trikotin III," der Magdeburger saccharinfabrik, by M. Wolff and A. Krausse, p. 490-5.

NOTES

The following notes appeared in the *Timber Trades Journal* (London) for September 16, 1922:

"In connection with the trading agreement with Mr. Leslie Urquhart, chairman of the Russo-Asiatic Consolidated Company, and the Soviet Government, it is pointed out that the company's assets in Russia include 20 saw mills for preparation of timber products for its own requirements and market purposes."

"The United States Shipping Board has accepted a bid of $750,000 for 226 of its fleet of wooden vessels, which were built during the war at an original cost of $300,000,000. What a loss!"

"It is stated that an important material for railroad ties and telegraph poles has been found by a French railway in the mangrove tree of French Guinea, no signs of rotting having appeared in severe tests continued four years. Not only is the grain so close that moisture is excluded, but the large amount of tannin contained gives protection against insects, moulds, etc."

New England Forestry Congress

The New England Forestry Congress, which is to be held December 27, 28, and 29, at the State House in Boston, under the auspices of the Massachusetts Forestry Association in celebration of its twenty-fifth anniversary, will be of particular interest to foresters. An elaborate program has been arranged covering a discussion of the New England forest resources and forest development. All State Departments of Forestry and Forestry Associations in New England and the Society of American Foresters are cooperating to make the event a memorable milestone in the progress of forestry in New England. Copies of the program may be obtained now from Mr. Harris A. Reynolds, Secretary of the Massachusetts Forestry Association, 4 Joy Street, Boston 9, Mass.

Maine's New Tax Law in the Toils

The 1920 Maine Legislature passed a so-called Auxiliary State Forest Act, patterned on a similar act of several years ago enacted by

the State of Pennsylvania. It provides for the classification, at the owner's option, of privately owned forest lands fulfilling certain requirements. The land alone is to be assessed and taxed annually. The timber to be taxed when cut.

Recently, a large land owner in the southern part of the State has endeavored to take advantage of this law and to classify some 30,000 acres overlapping into several adjoining towns. These towns, however, have declined to acknowledge the validity of the law and have brought suit, raising the question of its constitutionality. It is only surprising that the question has not been raised long since in other States, since it attacks an obvious point of common weakness.

In this connection, a recent adverse decision of the New Jersey Supreme Court, involving a similar constitutional point, is of interest. The question raised there was with reference to the constitutionality of an act exempting from taxation for five years all new buildings and the value of improvements to existing structures. The provision of the present New Jersey constitution has been held to authorize the classification of property and the exemption of classes or their taxation at special rates. The reason given by the Court for its decision is, that "new buildings are not a class of property, and that the conditions of this limited exemption are an arbitrary discrimination against old buildings."

Forests classified under such legislation as that in Maine, Vermont, Connecticut, Pennsylvania, and Michigan, where the special tax provisions rest upon a constitutional authority to classify property for purposes of taxation, are open to the same constitutional objection. It is perfectly evident that there is no difference, in fact, between a forest property classified under the provisions of the forest taxation law of any one of these States, and another property, equally well managed but not entered for special classification under such tax act. Such difference, if any, as exists between the two properties is not in the physical character of the property, nor in their productive use, not public service, but merely in the state of mind of the owners. On that basis the courts might very well follow the New Jersey precedent and declare the forest classification set up by these laws as arbitrary and discriminatory and against the other forests not classified.

Accordingly, the decision in the Maine case, if the unconstitution-

ality contention of the towns is upheld, will have a far reaching effect upon practically all existing forest taxation based on optional classification by the individual owner. L. S. M.

One-Seed Tree

What may be expected of single seed trees is well illustrated by a lone red pine, 45 feet high, located in a pasture near Durham, New Hampshire. In the 10 years—approximately—this 35-year-old tree has been bearing it has produced 216 seedlings ranging in height from 6 inches to 15 feet. These cover an area which is roughly oval in outline with its longest axis east and west. This latter is 230 feet long while the spread north and south is 150 feet. Fully 75 per cent of the seedlings are within 75 feet of the tree. In fact the seeding is only complete on the east side of the tree and within fifty feet.

Summarizing, the data from this single specimen would seem to indicate that satisfactory natural regeneration from scattered seed trees can only be expected for a distance not greater than their height and then only on the leeward side. K. W. W.

Transplanting of Large Forest Trees

A device for the transplanting of large forest tree stock has recently come to our attention. This device is described in a little pamphlet, entitled "A Device for Safely Transplanting Longleaf Pine and Other Evergreens," which has been gotten out by Lionel Weil, Goldsboro, N. C.

In transplanting longleaf saplings from the woods Mr. Weil, in common with many other persons who have attempted this met with little success. One tree which was transplanted during the winter when a ball of earth could be removed with the roots came through all right. This gave Mr. Weil the idea of constructing a receptable by means of which the roots could be removed with the tree even when transplating was attempted during a season when the soil was not frozen. The device, which in the pamphlet is described principally by a number of illustrations, is essentially a jacket of sheet iron which is provided with a pair of semi-circular side walls hinged together on one edge and provided with straps where the other two edges come together so that it can be strapped around a ball of earth while the tree stands

in place. In order to transplant the tree, it is first necessary to dig the earth away from it outside of a radius a small fraction less than the size of the top of the receptable and to dig down until the larger roots disappear, the depth, however, not to exceed the depth of the receptacle. This leaves the tree standing in place with a ball of earth around it that has all the appearance of a plant when it is removed with the dirt in place from a flower pot. The receptacle is now fitted around this ball of earth, some pins are inserted through the bottom so as to hold the dirt in place and the tree is removed. It can then be carried to its new situation and transplanted. Using this receptacle it is said that longleaf pine trees up to 5 feet in height can be safely transplanted and other difficult species of trees and shrubs as well. C. R. T.

Beaver Notes

The following observations were made by the writer during the summer and fall of 1921, while engaged in timber reconnaissance in Larimer County, Colorado.

While stopping for a drink on Beaver Creek, a tributary of the upper Laramie River, the writer discovered a tree stump in situ, which was being uncovered by the action of the water. The place appeared to be a small open park of grass and willows with pine saplings creeping in from the sides. Examination downstream disclosed an old beaver dam, the lines of which were still well defined and which still had a height of about 5 feet.

This led to numerous examinations of the creeks along with the work in hand. In all, between 10 and 12 old dam sites were examined in addition to two existing ponds and other areas showing indications of once having been beaver ponds. As nearly as could be determined from the signs on the ground, the following constituted the normal course of events. The pond was occupied only so long as the food supply lasted, or only so long as the pond remained large enough and deep enough to afford protection.

Silting in the mountain ponds progresses rapidly, due to the swift waters carrying considerable quantities of litter, mud, sand and even gravel in flood times. In the original pond if a few trees were killed by the flooding, these later fell and offered further barriers to the litter and silt.

Once the pond was abandoned by the beaver, the filling up process progressed rapidly. Two or three years after abandonment the beaver canals were practically dry and their course only indicated by depressions in the litter and silt. The upper end of the pond was usually overgrown with willows and alders and a heavy mat of alders were by this time established on the dam, binding it securely in place. The pond usually had a few patches of open water rapidly filling in with a growth of rushes and sedges. The last to fill in was the deep channel next to the dam which would produce a rank growth of sedges before it too finally filled.

Any time after the first year or two of abandonment the spring floods usually cut a creek channel through the dam (which usually occurred at one end of the dam, rarely in the center).

Once the creek had found a channel through, each spring flood deposited new silt on the pond surface, and while a very wet place in the spring, by late summer and fall the creek had receded and the old pond was very largely dry. Willows and grass come in rapidly under these circumstances.

Later, though just how long a period necessary could not be determined, the lodgepole pine seeded in from the sides. Grassy parks and willow flats were found supporting pines from a few years to twenty or thirty years of age, where the old dam was still clearly discernible.

It is not improbable that many a mountain meadow and mountain ranch owes its origin to the industrious work of succeeding generations of beaver.

LEE P. BROWN.

PENNSYLVANIA DEPARTMENT OF FORESTRY MAKES WHITE PINE SURVEY OF NORTHEASTERN PENNSYLVANIA

One of the most destructive enemies of white pine is the white pine blister rust. This disease was found at a few places in Pennsylvania from 1916 to 1918. During these three years only one stage of the disease—that which occurs on the white pine—was reported. All infected trees were destroyed, and no records are available showing that the disease was present in the State during 1919 and 1920.

On September 26, 1921, S. B. Detweiler, of the U. S. Bureau of Plant Industry, found the other stage of the disease on the leaves of

black currants growing on the property of Mrs. Letchy Lord, at Equinunk, Wayne County, Pa. During October the disease was also found on the estate of W. A. Lathrope, Montrose, Susquehanna County, and in a few additional places in Wayne County.

In order to ascertain the real status of the disease in Pennsylvania, and to be ready to meet any situation that may develop, the Pennsylvania Department of Forestry and the Pennsylvania Bureau of Plant Industry agreed to make a special study of the occurrence of the disease and the distribution of Ribes and white pine in the section of the State where the disease is present. It was decided that the three prerequisites of successful control measures are:

(1) Blister rust survey.
(2) Ribes (currant and gooseberry) survey.
(3) White pine survey.

It was agreed to that the Bureau of Plant Industry, which received an appropriation of $4,000 for blister work control, would take care of (1) the blister rust and (2) the Ribes surveys; and that the Department of Forestry would make (3) the white pine survey.

Representatives of the Department of Forestry began the field work of the white pine survey early in April, 1922, and by the end of May had completed the surveys of Wayne and Susquehanna Counties. The work was done carefully. Every commercial stand of white pine occurring in these two counties was examined by representatives of the Department of Forestry and a special report prepared for each forest property upon which white pine occurred in commercial quantities.

The white pine survey of Wayne County shows that there are 107 owners of white pine within the county, 77 of whom have it in merchantable sizes. The total estimated volume of merchantable white pine in the county is 1,977,575 board feet, of which 885,950 board feet occur in mixed stands and 1,091,625 board feet in pure stands. This merchantable white pine is distributed over 176 acres, and there are also 774 acres of forest land in the county with unmerchantable white pine upon it. In addition there are 1,726 acres upon which scattered unmerchantable white pine occurs in small quantities. The survey shows that white pine occurs on only 5,957 acres out of a total of 283,707 acres of forest land in the county, and that Ribes is present on 102 of the 107 forest properties upon which white pine occurs, but on only 7 of

these properties is it common, and on 16 it is sparse, and on 79 rare. Ribes was not abundant on any of the forest land stocked with white pine.

The survey of Susquehanna County shows that white pine occurs in only fourteen of the thirty-nine civil division into which the county is divided. It is present in commercial quantities on only forty properties, and the estimated volume of merchantable white pine in the county is 780,500 board feet. Only 92 acres are stocked with merchantable white pine and 51 acres with unmerchantable white pine. Scattered white pine occurs on 3,000 additional acres.

Of the forty properties upon which Ribes was found, it is common only on 2, sparse on 11, and rare on 27. Cultivated currant and gooseberries are present on or near six of the forty properties stocked with white pine; but in only three cases are they within infection range of white pine trees. Two owners of white pine have already destroyed all cultivated currants and gooseberries on their properties, and two other property owners are contemplating the same control measure.

The survey of these two counties shows that white pine is a subordinate member in the forest structure, that the stands are widely distributed, and that native Ribes are rare within or in close proximity to the stands. The present widely scattered distribution of white pine, and currants and gooseberries in Wayne and Susquehanna Counties create a hopeful situation for the control of the white pine blister rust. There is no need for alarm. Even if the blister rust should become more prevalent than it now is, its handling will not be difficult, for practical local control measures are available and can be used economically.

JOSEPH S. ILLICK.

EVEN-AGED STANDS IN WESTERN YELLOW PINE

Weidman, in an article appearing in a recent issue of the JOURNAL OF FORESTRY, reaches the conclusion that western yellow pine in the Northwest should be handled in even-aged stands rather than as selection forests. He bases this conclusion upon the fact that in virgin stands 69 per cent of the trees are over 200 years old, thus approaching more nearly the even-aged than the selection forest. The presence of immature trees is attributed to restocking of openings caused by accidental death of individuals in the main age-class. The proportion of young trees increases as the stands become overmature. Weidman believes

that yellow pine stands in the Northwest will remain even-aged through a rotation of 180 years. He estimates that such stands will yield 48,000 feet b.m. as against 36,000 for uneven-aged or selection forests.

Weidman states that, "Where a body of yellow pine is found containing a large proportion of pole age-classes, it would certainly be unwise to sacrifice this profitable growing stock by cutting it clear." This is the condition which prevails in Arizona and New Mexico. Here the immature trees above 12 inches d.b.h. outnumber the mature and overmature ones. No forester would think of sacrificing this growing stock at the present time. But if the yield can be materially increased by converting the stands to an even-aged condition this might be considered at some future time. It would be possible to secure even-aged reproduction by taking advantage of advance growth in virgin stands, or by leaving about four large seed trees per acre. In the former case, blanks would occur around the spaces occupied by large tree groups, and it would in most cases be necessary to leave seed trees to restock these spaces. Good silviculture would require that seed trees be removed after the ground becomes well stocked.

Assuming that uniformly distributed, even-aged reproduction were secured, would it grow to maturity as a uniform even-aged stand? All examples which throw direct light on this question tend to answer in the negative. It is probable that long before the end of the rotation (150 to 200 years) the trees would die out on fully one-half of the area, during periods of abnormal drought. The openings thus formed would later restock, giving rise to one or more younger age-classes. It is exceedingly doubtful whether western yellow pine in Arizona and New Mexico can be handled as even-aged stands.

The primary difference between conditions in the Southwest and in the Northwest and California is in precipitation. In the Southwest, the precipitation is not generally sufficient to mature the dense, unbroken stands of young trees which start under favorable conditions. The result is that trees die out in patches, thus bringing about the characteristic group formation. Once this arrangement is established, it is maintained automatically. Grouping is most pronounced in the localities least favored as to moisture, and it tends to disappear where moisture is relatively abundant.

G. A. Pearson.

SOCIETY AFFAIRS

Changes in Section Officers

Since the recent membership list was printed, the following changes have taken place in the officers of Sections:

Washington Section elected for the year 1922-1923:

Chairman, O. M. Butler.

Secretary-Treasurer, Ward Shepard.

Executive committee, these two and Carl M. Stevens.

Denver Section elected Earl W. Tinker as Secretary, in place of Wallace J. Pearce, resigned.

Madison Section elected E. V. Jotter as Secretary, in place of Edward P. Ancona, resigned.

Annual Meeting

The annual meeting of the Society will be held in Room 427 of the State House at Boston, Friday and Saturday, December 29 and 30. On Thursday, December 28, joint sessions will be held in connection with the meeting of the New England Forestry Congress and the Economics Section of the American Association for the Advancement of Science, which is headed this year by Col. Henry S. Graves. The business meeting of the Society will be held on Saturday morning. Headquarters have been arranged for at the Hotel Bellevue, Beacon Street, and the Committee suggests that members desiring accommodations communicate directly with the hotel. A smoker is planned for Friday evening at the Harvard Club. Final programs will be mailed to all members soon after December 1.

Membership

The following have been elected to membership in the Society, effective November 13, 1922:

Senior Membership.—Valentine M. Bearer, Raymond P. Hopson, Frank J. Klobucher, M. C. Warren.

Membership.—C. K. Cooperrider, Perry Emigh, Claude W. McKenzie, J. C. Nave, Marcel F. Pincetl, J. H. Price, Willis M. Wagnener.

Comments on Proposed Amendments

By B. P. Kirkland:

I think we must recognize that the present method of electing Members is far too slow, as it results in a delay of one year before any person can gain admission to the Society. Personally, I do not see that there should be a very great objection to letting the Sections name the Members to the Society, but in that case would provide for veto power by a committee of three of the Executive Council, or for election by concurrent action of the local Section and the Council committee of three on admissions.

By W. N. Sparhawk:

Amendment Number 1 (Article III, Section 2). It seems to me to be highly undesirable to have thirteen or more different standards by which to choose the few hundred men at most who will be eligible for membership in the next few years. The various Sections now have widely divergent ideas as to the qualifications requisite for membership, and if their recommendations were not passed upon by some central authority they would doubtless grow even farther apart. Membership in the Society, even in the Member grade, ought to mean something definite. It won't under the plan suggested.

Possibly some of the Sections may have overlooked the provision in Article VIII, Section 3, which states that any Section may, with the approval of the Executive Council, adopt qualifications for associate members of the Section. Such members do not become members of the Society, nor need they possess the qualifications requisite for membership in the Society.

Amendment Number 2 (Article V, Section 1). In the first place, the idea that the Washington Section controls the Society is not well founded. The Washington Section can claim only about one-seventh of the voting members of the Society, and as a matter of fact many of them fail to vote. The Section was organized in 1916. Since then, the President of the Society has been a member of this Section once (1922), and the Vice-President once (1919). In the other five years, the California Section has furnished the President once, the New England Section twice, and twice he was not connected with any Section. The Vice-President was selected once each from the California Section, the St. Paul Section, the Denver Section, and the New England

Section, and one year was not affiliated with any Section. The Secretary and the Treasurer are usually chosen from (not by) the Washington Section purely for reasons of convenience, because of the need of having a definite headquarters at some one place and the impracticability of moving several tons of files and back issues of the JOURNAL and Proceedings from place to place every year.

Aside from the above, my objections to the proposed amendment are based on the following considerations:

1. The number of Sections is not fixed. There are now 13, and within a comparatively short time there probably will be several more. To have one member on the Council for each Section would result in a Council even more unwieldly than the present one of 10 members, and would slow up action considerably.

2. A comparatively large number of members who are not affiliated with any existing Section, would have no voice in the election of the Council under this plan.

3. Election of one member by each Section, regardless of its size, would be unfair, giving undue influence to the members of small Sections. The 417 Senior Members and Fellows are distributed approximately as follows according to geographic location, disregarding possible affiliations outside of geographical boundaries:

Unattached	60	Northern Rocky Mountain	25
Washington	57	Southern Appalachian	24
New England	45	Denver	21
North Pacific	41	Intermountain	15
New York	33	Madison	15
California	30	Southwestern	11
Pennsylvania	30	St. Paul	10

Under the proposed plan, five Sections with an aggregate membership of 72 would choose five members of the Council, while the two Pacific Coast Sections with 71 members would choose only two, and the five Atlantic Coast Sections with 189 members would also have only five votes. The 60 unattached members would have no vote at all.

4. Under this plan the Society would be likely to be very largely an adjunct of the Forest Service, and there would be much more reason than there is now for the assertion that the Service controls the Society. Of the 13 Sections, nine are dominated to a large extent by Forest Service members, although only about 160 of the 417 Senior Members and Fellows are connected with the Forest Service.

5. The Society is yet too small to be converted into a federation of semi-independent sectional societies or provinces. When the membership of the average Section approaches a figure equal to the present total membership of the whole Society, it may be desirable to adopt some scheme of federation along the lines proposed. Meanwhile, the Sections should avail themselves of their right to nominate candidates for any offices they may choose. (See Article V, Section 3, of the Constitution.)

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